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CUTTING BEVEL GEAR TEETH—A NEW METHOD OF OBTAINING THE SET-OVER*

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PERHAPS the most troublesome of the more common milling machine operations is that of cutting the teeth of bevel gears. Tables, explicit directions and formulas have been prepared for indexing, and for cutting spirals, cams, end-mill teeth, etc., but the shaping of a passably good bevel gear tooth has always been a matter of judgment and "cut-and-try." The writer, with the cooperation of the Brown & Sharpe Mfg. Co., herewith presents a method of setting the

the tables in the Brown & Sharpe gear book for the different pitches, or may be found by dividing 1.157 by the diametral pitch). The thickness of the cutter at the pitch line as measured at this depth by the vernier tooth caliper is the dimension used in calculations.

It should be noted that when the table herewith presented is used for obtaining the set-over, the cutting angle must be determined as shown in Fig. 4. That is to say, the gears must be cut with a parallel clearance depth, in the way recommended by the Brown & Sharpe gear book as more closely approximating the true form than when the bottom of the tooth space is radial with the vertex of the pitch cone. This cutting angle is evidently found by subtracting the addendum angle θ from the pitch cone angle a . The milling machine is set up for cutting bevel gears in the usual manner with the work-spindle set at this angle, the cutter centered with the work and set for the full depth of tooth. If the gear is

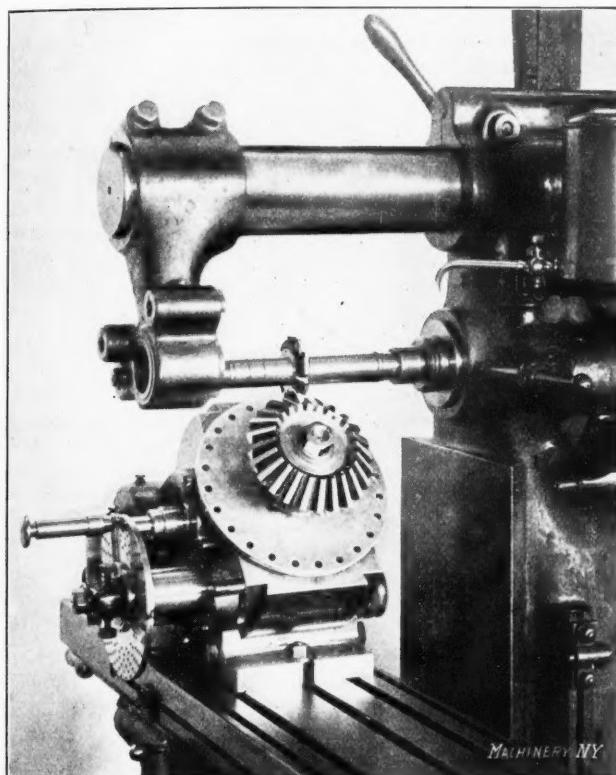


Fig. 1. Milling Machine set up for Cutting a Bevel Gear

milling machine (or automatic gear cutting machine) for cutting the teeth of bevel gears, in which experimental trial cutting is nearly, if not quite, avoided, thus opening possibilities for a material saving in time, and improvement in the quality of the product. The method also enables much better results to be obtained in the hands of an operator unfamiliar with this rather difficult work. The whys and wherefores of the operation will be described from beginning to end, so as to give a clear understanding of the principles involved. First, however, the process itself will be described, so that the reader who does not care to go into the whys and wherefores will be able to use it.

Setting up the Machine

In cutting bevel gears by this process we are supposed to have given the number and pitch of the cutter we are to use, the diametral pitch of the teeth to be cut, the width of face of the gear (F in Fig. 2), the pitch cone radius of the gear (C in Fig. 2) and the thickness of the bevel gear cutter at the pitch line. The latter (which is variable) is best obtained by the Brown & Sharpe gear tooth caliper shown in use measuring a bevel gear tooth in Fig. 3. This should be set to measure the cutter at a depth $S + A$, in Fig. 2, which is the whole depth below the pitch line (this is given as $S + f$ in

* For further information on this subject, see "Cutting Bevel Gears with a Rotary Cutter," October, 1907, and articles there referred to, and "Accurate Setting of the Bevel Gear Cutter," in this issue.

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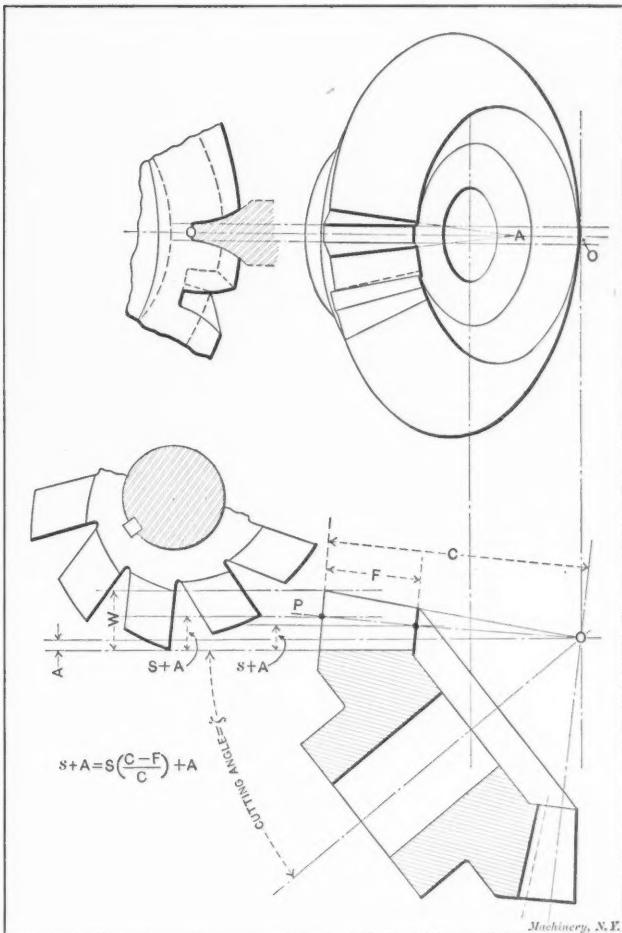


Fig. 2. Relative Positions of Cutter and Blank when taking Central Cut of fairly coarse pitch it is best to cut clear around it with this setting, thus roughing out all the tooth spaces. On fine pitch gears this roughing cut is unnecessary.

Calculating the Set-over

In cutting bevel gears, in order to cut a tooth approximating the correct form, it is necessary to take two cuts through each tooth space with the work-spindle set off center with relation to the cutter, first on one side, and then on the other, rolling the blank correspondingly to obtain the proper thickness of tooth at the large and small ends. It is proposed to

find the amount of this set-over from the accompanying table by the following formula:

$$\text{Set-over} = \frac{T_c}{2} - \frac{\text{factor from table}}{P} \quad \dots \dots \dots (1)$$

Given as a rule, this would read: *Find the factor in the table corresponding to the number of the cutter used and to the ratio of pitch cone radius to width of face; divide this factor by the diametral pitch, and subtract the result from half of the thickness of the cutter at the pitch line.*

As an illustration of the use of this table in obtaining the set-over we will take the following example: A bevel gear of 24 teeth, 6 pitch, 30 degrees pitch cone angle and $1\frac{1}{4}$ face. These dimensions, by the ordinary calculations for bevel gears* which it is not necessary to go into here, call for a No. 4 cutter and a pitch cone radius of 4 inches.

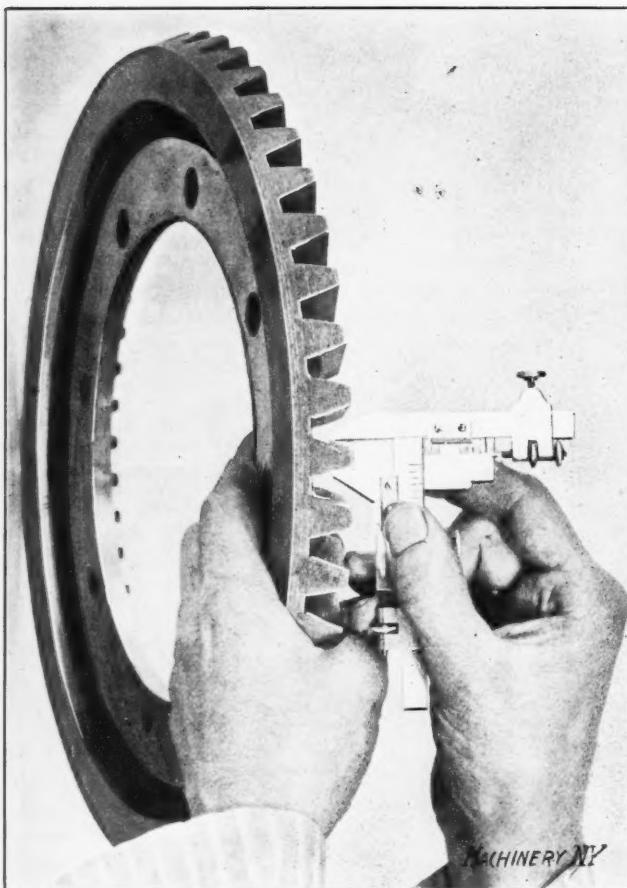


Fig. 3. Brown & Sharpe Gear-tooth Caliper in Use

In order to get our factor from the table, we have to know the ratio of pitch cone radius with length of face. This ratio is $\frac{4}{1.25} = \frac{3.2}{1}$ or about $3\frac{1}{4}$. The factor in the table for this ratio with a No. 4 cutter is 0.280. We next measure the cutter at the proper depth of $S + A$ for 6 pitch, which is found in the column marked "depth of space below pitch line" in a regular table of tooth parts, or by dividing 1.157 by the diametral pitch. This gives $S + A = 0.1928$ inch. We find, for instance, that the thickness of the cutter at this depth is 0.1745 inch. This dimension will vary with different cutters, and will vary in the same cutter as it is ground away, since formed bevel gear cutters are commonly provided with side relief. Substituting these values in Formula 1, we have

$$\text{Set-over} = \frac{0.1745}{2} - \frac{0.280}{6} = 0.0406 \text{ inch,}$$

which is the required dimension.

The work must now be set off center on one side of the cutter by this amount, taking the usual precautions to avoid errors from back-lash. In this position the cutter is run through the blank, the latter being indexed for each tooth space until it has been cut around. (If a central or

* Rules and formulas for bevel gear calculations will be found in MACHINERY's Data Sheet No. 69, May, 1907, and in Reference Series No. 37, "Bevel Gearing."

roughing cut has been previously taken as suggested in an earlier paragraph, it will be necessary to line up this cut at the small end of the tooth with the cutter. This is done by rotating the tooth space back toward the cutter, either by moving the index crank as many holes in the dial-plate as are necessary, or by means of such other special provisions as may be made for doing this in the index head, independently of the dial-plate.)

Having thus cut one side of the tooth to proper dimensions, the work must be set-over by the same amount the other side of the position central with the cutter, taking the same precautions in relation to back-lash as before, and rotating the blank to again line up the cutter with the tooth space at the small end of the tooth. With this setting, take a trial cut. This will be found to leave the tooth whose side is trimmed in this operation a little too thick, if the cutter is thin enough, as it ought to be, to pass through the small end of the tooth space of the completed gear. This trial tooth should now be brought to the proper thickness by rotating the blank toward the cutter, moving the crank around the dial for the rough adjustment, and bringing it to accurate thickness by such means as may be provided in the head. In the Brown & Sharpe head, as shown in Fig. 1, this fine adjustment is effected by two thumb-screws near the hub of the index crank, which turn the index worm with relation to the crank.

Testing for Correctness of the Setting

With reference to the use of the table and formula, the Brown & Sharpe Mfg. Co., after trial in their gear cutting department, say: "We feel fairly confident it is within working limits of being satisfactory." While this sounds encouraging, it will evidently be wise to be sure we are right before going ahead, as the slight approximations involved in the derivation of the formula (to be explained later) may bring the setting not quite right, so that the thickness of the tooth at the large and the small ends is not what it ought to be. This point may be tested by measuring the tooth at both the large and the small ends with the vernier caliper as shown in Fig. 3, the caliper being set so that the addendum at the small end is in the proper proportion to the addendum at the large end—that is to say, that it is in

$C - F$
the ratio $\frac{C}{F}$. In taking these measurements, if the thicknesses at both the large and the small ends, which should be in this same ratio, are too great, rotate the tooth

TABLE FOR OBTAINING SET-OVER FOR CUTTING BEVEL GEARS

No. of Cutter	Ratio of Pitch Cone Radius to Width of Face ($\frac{C}{F}$)												
	3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	5	$5\frac{1}{2}$	6	7	8
1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	.254	.254	.255	.256	.257	.257	.257	.258	.258	.259	.260	.262	.264
3	.266	.268	.271	.272	.273	.274	.274	.275	.277	.279	.280	.283	.284
4	.266	.268	.271	.273	.275	.278	.280	.282	.283	.286	.287	.290	.292
5	.275	.280	.285	.287	.291	.293	.296	.298	.298	.302	.305	.308	.311
6	.280	.285	.290	.293	.295	.296	.298	.300	.302	.307	.309	.313	.315
7	.311	.318	.323	.328	.330	.334	.337	.340	.343	.348	.352	.356	.362
8	.289	.298	.308	.316	.324	.329	.334	.338	.343	.350	.360	.370	.376
9	.275	.286	.296	.309	.319	.331	.338	.344	.352	.361	.368	.380	.386

NOTE.—For obtaining set-over by above table, use this formula:

$$\text{Set-over} = \frac{T_c}{2} - \frac{\text{factor from table}}{P}$$

P = diametral pitch of gear to be cut.

T_c = thickness of cutter used, measured at pitch line

toward the cutter and take another cut until the proper thickness at either the large or small end has been obtained. If the thickness is right at the large end and too thick at the small end, the set-over is too much. If it is right at the small end and too thick at the large end, the set-over is not enough, and should be changed accordingly, as is done by the regular "cut-and-try" process. The formula and table herewith given, however, ought to bring it near enough right the first time, and in the general run of work it can be safely relied on.

It may be said, in this connection, that nothing but a true running blank, with accurate angles and diameters, should be

used in setting up the machine. If such a blank cannot be found in the lot of gears to be cut, it will be necessary to turn one up out of wood or other easily worked material. Otherwise the workman is inviting trouble, whatever his method of setting up.

Filing the Teeth

The method of cutting bevel gears just described requires the filing of the points of the teeth at the small end. This can be done "by the eye" very skillfully when the workman is used to it. The operation consists in filing off a triangular area extending from the point of the tooth at the large end to the point at the small end, thence down to the pitch line at the small end and back diagonally to the point at the large end again. This is shown in Fig. 5, by the shaded outline.

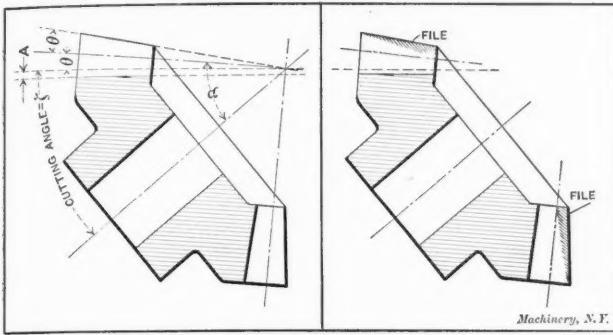


Fig. 4. Parallel Clearance, best adapted to shaping with Formed Cutter

Fig. 5. Shaded Area shows Part of Tooth to be corrected by Filing

Enough is taken off at the small end of the tooth so that the edges of the teeth at the top appear to converge at vertex O in Figs. 2 and 6.

The bevel gears may be tested for the accuracy of the cutting and filing by mounting them in place in the machine and revolving them at high speed, or by mounting them in a testing machine made for the purpose. The marks of wear produced by running them together under pressure, with the back faces flush with each other, should extend the whole length of the tooth at the pitch line. If it does not, the amount of set-over allowed in cutting them was at fault, being too little if they bear heavily at the large ends, and too much if they bear heavily at the small ends. The bearing area should also be fairly evenly distributed over the sides of the teeth above the pitch line, from the large to the small end. If it is not, the filing is at fault. The marks of wear will not in any case extend far below the pitch line in a pinion of few teeth.

It is possible to get along without filing by decreasing the amount of set-over so as to make the teeth too thin at the pitch line at the small end, when they are of the right thickness at the large end. This does not give as good running gears, however, as when the method just described is followed.

Cutting Bevel Gears on the Automatic Gear-cutting Machine

The directions for cutting bevel gears on the milling machine apply in modified form to the automatic gear cutting machine as well. The set-over is determined in the same way, but instead of moving the work off center, the cutter spindle is adjusted axially by means provided for that purpose. Some machines are provided with dials for reading this movement. The cutter is first centered as in the milling machine, and then shifted—first to the right, and then to the left of this central position.

The rotating of the work to obtain the proper thickness of tooth is effected by unclamping the indexing worm from its shaft (means usually being provided for this purpose) and rotating the worm until the gear is brought to proper position. Otherwise the operations are the same as for the milling machine.

Derivation of Formula

The derivation of the formula and the method of calculating the table need not concern the workman who desires to use them, as he can employ them with no knowledge of mathematics other than that required for plain subtraction and division. For those, however, who desire to understand the origin of the table, the following explanation will be interesting.

Fig. 6 shows a section such as would be made by turning off the bevel gear blank down to the pitch cone—in other words, it is a section on the conical surface PO of Fig. 2. The same dimensions apply to both figures. We find, if we take a cut with the cutter set central, that the side of the tooth space will not pass through the vertex O , but through some point O' at one side. The distance between O' and O is X , which is the amount by which the cutter will have to be offset to bring the side of the tooth space at the pitch line radial with vertex O . A formula can be derived by simple proportion to obtain this offset, in terms of T_c , t_c , F and C . The formula is:

$$X = \frac{T_c}{2} - \left(\frac{T_c - t_c}{2} \times \frac{C}{F} \right) \quad (2)$$

This determination of the set-over, of course, involves one or two approximations of minor importance, which will be readily perceived from an examination of the diagrams.

While this formula seems to furnish a means for obtaining by measurement and calculation the amount of set-over, it is rather clumsy. It remains therefore to put it in more usable form. From an examination of the formula, we note that

$\frac{T_c}{2}$ while $\frac{T_c - t_c}{2} \times \frac{C}{F}$ is a variable, depending on the thickness of the cutter,

ter, the quantity in parenthesis remains constant as the cutter grows thinner from being ground down. In fact, by taking the measurements T_c and t_c on a one diametral pitch cutter, and calling them T'_c and t'_c it would be possible to put this in the form:

$$X = \frac{T_c}{2} - \frac{1}{P} \left(\frac{T'_c - t'_c}{2} \times \frac{C}{F} \right) \quad (3)$$

in which the quantity $\frac{T'_c - t'_c}{2} \times \frac{C}{F}$ would be constant for all

cases of all pitches having the same ratio of $\frac{C}{F}$ and using the same number of cutter.

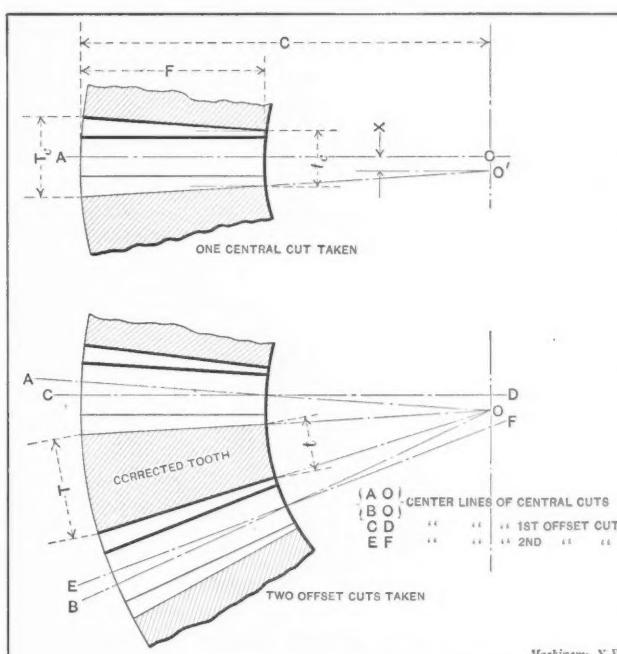


Fig. 6. Section on Pitch Cone Surface $P O$ of Fig. 2, showing Central and Offset Cuts

Now it is possible to put this formula in still simpler form

by tabulating the values of $\frac{T'_c - t'_c}{2} \times \frac{C}{F}$, as measured on a

one pitch cutter, for different values of $\frac{C}{F}$. This has been

done in the table for thirteen values of $\frac{C}{F}$, which cover the

major part of the bevel gears cut by the formed tool process. Using the factor as given in the table, the formula reads:

$$X = \text{set-over} = \frac{T_c}{2} - \frac{\text{factor from table}}{P} \quad (1)$$

as we have already given it.

The method of filling in the table will be easily understood. A one pitch cutter is measured with the Brown & Sharpe gear tooth caliper at depth $S + A$ for dimension T_c and at depth $s + A$ for t_c (see Fig. 2). Of course, $s + A$

and consequently t_c will vary, as $\frac{C}{F}$ is taken $\frac{3}{1}$, $\frac{3\frac{1}{4}}{1}$, etc., respectively. Having found these dimensions, the quantities to fill in the table are evidently obtained by the formula:

$$\text{Factor from table} = \frac{T_c - t_c}{2} \times \frac{C}{F} \quad (4)$$

Use of the Formula for Other Methods of Approximation

It would seem as though the form of table and formula here given would be suitable for recording for future use the amount of set-over obtained by the "cut-and-try" process for other methods of approximation than that here given. Transposing Formula 1 to solve for the factor, we have

$$\text{Factor from table} = P \left(\frac{T_c}{2} - \text{set-over} \right) \quad (5)$$

in which the measurement as before is taken on the cutter used for the job. By recording the factors for all jobs done, and thus gradually filling in the tables from his own practice, the machinist would be able to put the data in usable form to apply to future jobs.

It is customary also among workmen expert in cutting bevel gears with formed cutters, to cut loose from rules and formulas for the selection of the cutters, and depend on their experience to get shapes which require somewhat less filing than would otherwise be necessary. Whenever this "cutting loose" requires, as it sometimes does, the use of a cutter of finer pitch than that of the teeth of the bevel gear at the large end, Formula 1 and the table are inapplicable. Formula No. 2 may then be used. This has been tried on several widely varying cases with good results. It requires, it will be seen, two measurements of the cutter in place of the single one required when the regular pitch of cutter is used.

Other Methods for Calculating the Set-over

At least two other attempts have been made to give values for the settings required in cutting bevel gears. The first of these was described by Mr. Jacques in the June 7, 1900, number of the *American Machinist*. The second was described by Prof. Forrest R. Jones in a paper at the December, 1896, meeting of the American Society of Mechanical Engineers. Of these methods the first, while aiming at the same results as obtained by the author, is impracticable, owing to the fact that it requires a peculiar design of machine for its successful use. The method here described may evidently be used in any machine in which the cutter can be adjusted axially, and in which the work can be rotated on its spindle. It may thus be used on the plain automatic gear cutting machine as well as on the milling machine. It may be even employed in the same identical way for a formed tool in the shaper, the same measurements being made and the set-over being read on the graduated dial of the table cross-feed screw.

Professor Jones' method was the result of long experiment and careful study. Its drawbacks are, first, the fact that it is designed for a method of approximation in which the tooth shape is obtained as nearly as possible from the cutter, without corrective filing; second (and principally) because it gives the setting in terms of rotation of the blank instead of the set-over of the cutter. There can be no question as to which of these dimensions is the deciding one in obtaining the proper tooth shape. It is the setting of the cutter off center which determines whether or not the side of the tooth at the pitch line shall be radial with the vertex of the pitch cone. The effect of the rolling or rotating of the blank is simply that of changing the thickness of the tooth, not of changing its shape. If the workman is directed to first roll the blank a certain amount and then shift the cutter sideways to obtain the proper thickness, he has in mind the thick-

ness and not the shape in making the last adjustment, and according to whether he makes the teeth thicker or thinner, so will the shape be changed; and for the same reason such a rule will give different shapes of teeth with similar cutters of varying thickness.

Practical Results from the Use of the Table

The methods obtained with the templet process and, above all, with the generating process, are so much superior to those obtained with the milling cutter that the use of the latter should be avoided wherever possible. It has a legitimate field, however, on gears too small to be cut on any commercial planing machine. In general, it is not considered advisable to plane gears having teeth finer than 10 to 12 diametral pitch. It is allowable, however, to mill gears of coarser pitch which are to run at slow speeds, or which are to be used only occasionally—such, for instance, as the bevel gears used for turning the elevating screws of a planer cross-rail, or those used in connection with other hand-operated mechanisms. Under ordinary conditions it is impracticable to mill bevel gears having teeth coarser than 3 diametral pitch, no matter what the service for which they are to be used.

Two of the approximations involved in this method may be mentioned. In Fig. 2, it will be noticed that the various dimensions W , $S + A$, etc., are taken perpendicular to the bottom of the tooth, instead of perpendicular to the pitch line as they should be. The setting of the cutter to depth by this usual method, therefore, involves an error, but it is so slight as to be negligible. The other approximation relates to the use of the uncorrected tooth thickness and addendum for measuring the cutters in preparing the table. The chordal tooth thickness might have been used, but at the cost of a considerable complication in the process. It was found by investigation that this refinement would not affect the final result enough to make it worth while.

The Brown & Sharpe Mfg. Co. has been trying this method of setting the milling machine and automatic gear cutter for the past four or five months, first in an experimental way, and later in regular practice. The workman can with confidence cut a trial tooth with the set-over given and expect to find it (in an 8-pitch gear, for instance) about as close to size as he would naturally measure, so far as thickness of the tooth at the large and small ends is concerned.

The writer's thanks are due to the Brown & Sharpe Mfg. Co. for the very kind attention given to this matter, both in the experimenting in the shop, and in the preparation of the table in the drafting-room.

* * *

The whitewashing of coal, says the *Railway and Engineering Review*, would seem to be a rather silly proposition; but it is not done for looks, nor to change the quality of the material. It is rather a simple detective scheme said to be effective. The purpose is to locate loss of coal from open cars by theft or otherwise, in transit. The top of the load is sprayed with lime water—an easy and cheap process. It is thus whitened as the water evaporates, and the appearance is that of a load of white coal. Any disturbance of this surface by removal of even a small quantity is readily noticeable. By observing this at division and junction points, the place of the disappearance can be approximately located. This plan has been tried on some western roads, but has been abandoned solely on account of the opposition of dealers who claim that their customers do not want coal so treated. As the quality of the coal is unaffected, there can be no reasonable objection to it. The real reason is believed to be that dealers prefer not to get the protected coal but prefer the opportunity of making claims for alleged losses in transit. If this is the fact, there is a condition into which railway commissions, state or national, might well look. It is to the best interest of shippers and carriers that there should be no losses in transit, and no bogus claims for alleged losses.

* * *

About one-third of an ounce of radium-chloride, equivalent to about one-thirtieth of an ounce of pure radium, was the total output of the Joachimsthal mines in Austria for eighteen months. The radium will be sold for about \$5,000 a grain.

DIES AND METHODS FOR MAKING WATCH CROWNS

GEO. J. MURDOCK*

The art of making watch crowns is one of the most interesting branches of precision mechanics, and of comparatively recent development, as watches, like clocks, were originally wound with a key. In the course of the refinement of the watch it was discovered that a watch key was a very elusive article, which, being small, was easily mislaid or lost.

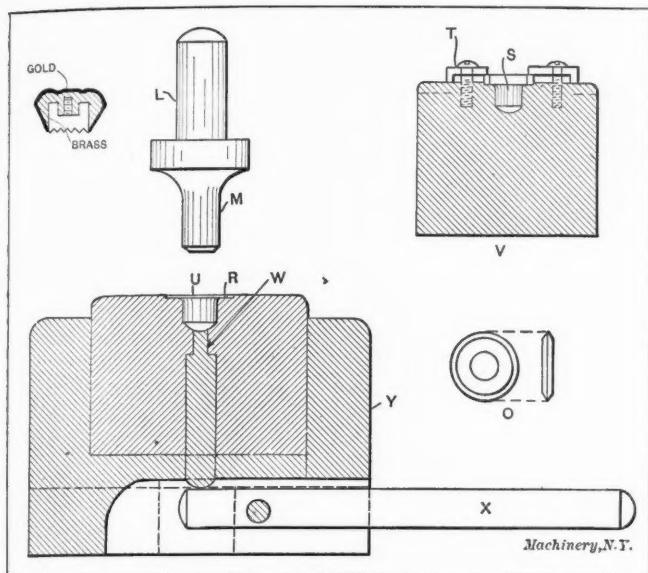


Fig. 1. Dies used in making Watch Crowns

The stem-winding, and finally the stem-setting watch was improved so as to render the key unnecessary, and with this improvement came the watch crown. In the beginning, it was globular, or nearly so in shape, but in recent years the style known as the antique crown has almost completely superseded the old form, particularly on American watches.

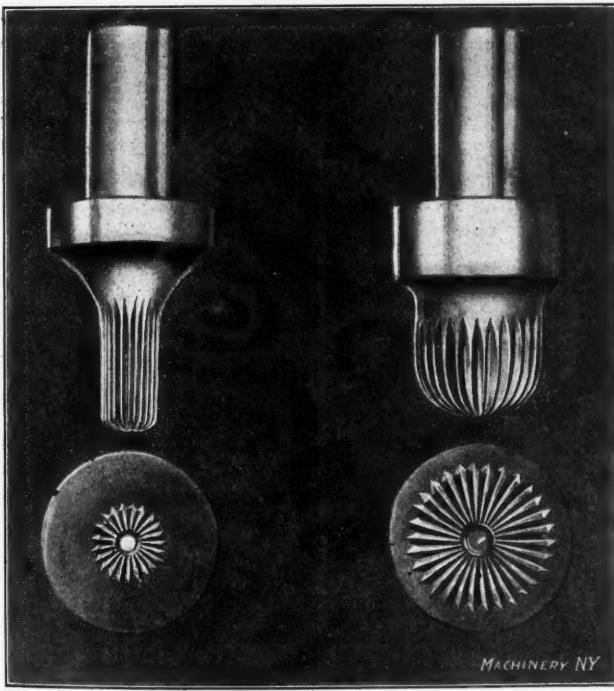


Fig. 2. Two Punches used for Forming the Gold-plated Outer Shell

There are numerous sizes made which are numbered from 0 to 24 or larger. The small sizes are used mainly on ladies' watches, while those for men seldom range above size 18.

Such a thing as a solid gold crown is unusual, the practice being to make a central hub or core of brass, over which is drawn a filled or solid gold shell, as shown in the sectional view in the upper left-hand corner of Fig. 1. Manufacturers

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at the present time seem to be unanimous in two particulars: First, the brass hub is made just as large and heavy as possible; and second, the shell over the brass is made just as thin as the trade will allow. The reasons for this are obvious. Thus it will be understood that when one has what he fondly imagines is a solid gold watch in his pocket, it is composed, in reality, mainly of brass and steel.

The machinery required in the making of tools for watch crowns, is a screw press, lathe, and a small universal milling machine. In making the dies, the punch for the gold shell is the first thing to make. A punch of hard tool steel such as is used for one of the final operations is shown in Fig. 1, and also at the left in Fig. 2. It has a shank *L*, and point *M* which is fluted on the milling machine with the correct number of divisions for its size. These divisions are standard for the different sizes, and must be very smoothly cut by a small V-shaped 60-degree milling cutter such as shown at *O*. The fluting of the punch necessitates not only a keen cutter, but such an exercise of skill on the part of the toolmaker as will produce a surface on the flute free from chatter marks or blemishes of any kind. The perfection of the punch in this respect should be followed by a die that is also perfect. After the flutes are cut in the punch both on the sides and

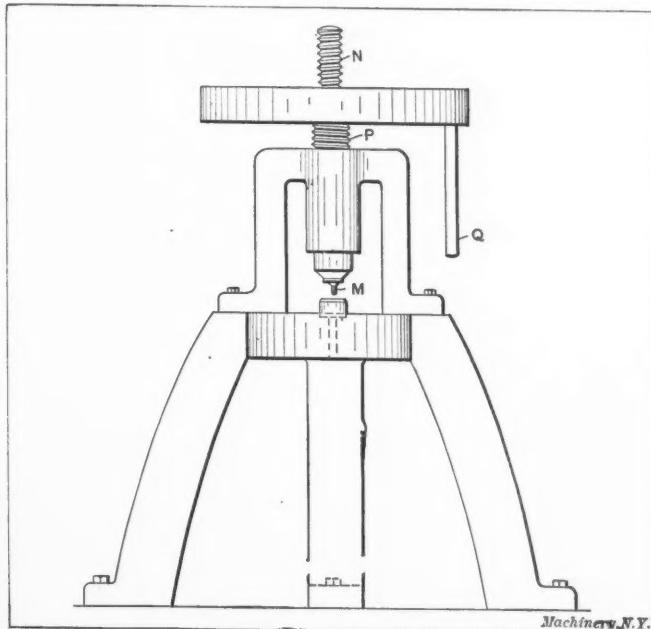


Fig. 3. Screw Press in which Dies and Crowns are made

end to the center, the part that forms the crown top is turned (usually by hand) to a gage, as shown in the end view in Fig. 2. I will state here that the top of a watch crown is the small central hub on the top where the flutes end. The bottom or point of the punch is turned to this shape, as shown, and to the exact diameter that the body of the hub on the finished crown is to be.

The punches, when ready to be hardened, are packed in a cast iron box with a mixture of powdered charcoal and bone-dust. The cover is then luted with fire-clay so as to make it air tight, and the box with its contents is heated long enough to bring the punches to the right temperature for hardening. They are then taken out one by one, and dipped vertically in lukewarm water. Care is taken to keep those that are in the box covered with the charcoal, for an exposure to the air even for a few seconds will cause them to scale so as to render it impossible to get them of the necessary smoothness again. Before packing the punches they should be slightly warmed and dipped in the following solution: Boracic acid, 1½ ounce; aqua ammonia, 2 ounces; powdered borax, 1 ounce; potassium cyanide, ½ ounce. This solution is dissolved by boiling it in ½ gallon of rain water. It forms a protection to the finished surface of the punch, and assists in keeping it from scaling. If it is used, the punches will come out bright, and nearly as smooth as when put in the fire, which is a very essential thing to consider in work of this class. After hardening, the punches are scratch-brushed (not buffed), and then put into a muffler and drawn to a clear straw color all over. When cold, the

point *M* is dipped in water, and with a gas blow-pipe, the shank *L* and the enlarged part of the punch is drawn to a dark blue, while the point as far as it is in the water will remain a straw color.

The die is usually about $2\frac{1}{2}$ inches in diameter by $1\frac{1}{2}$ inch thick, and the blank is turned all over so as to be round, and parallel on the top, and bottom. For the smaller sizes, the spot where the punch will strike in sinking, should be smoothly polished. The die is set in a recess on the bed of the screw-press, as indicated in Fig. 3, and the punch *M* is brought gently down on it. The screw-press is made with a compound screw *N* and *P* which, together with a heavy fly-wheel actuated by the handle *Q*, gives it great power. Before beginning the operation of sinking the die, the punch should be wet with the following mixture, which seems to have a softening effect on the steel of the die, causing it to give away with greater ease before the punch; in addition, the sunk surface will remain smooth in service longer than when oil is used: sulphuric ether, 6 drams; pulverized camphor, 2 ounces; enough oil of turpentine to fill a 6-ounce bottle.

In sinking the die, it should be held down in the recess in the bed-plate of the press with the right hand, while with the left the wheel is swung so as to move the plunger of the press with the punch up and down. Too much force must not be

exerted, it may still be saved, or if the splinter has injured it only slightly it may be used for a larger size. The old method of sinking, especially with the large sizes, was to heat the die red hot, and then bring the punch down on it, a proceeding that was almost sure to ruin the punch, and produce a die more or less rough and pitted. With the sinking fluid mentioned, however, dies of any size can be sunk cold with ease, and the hot method is no longer used by up-to-date tool-makers.

After the die is sunk, it is put on the face-plate of a lathe, and indicated until the pit in the die comes central, and then a recess *R* (Fig. 1) is turned concentric with the pit to receive the round blank *A* (Fig. 4) which is to form the shell of the crown.

Machinery, N.Y.
Fig. 6. Punch and Die for Closing Crowns
as at H, Fig. 4

the shell of the crown. The stock from which the shells are made varies in thickness for different sizes, but for an 18 size it would be 0.012 of an inch thick for filled stock. In some cases instead of the recess *R*, a nest *S* is made to hold the blank. Holes are then drilled and tapped in the top of the die as shown, and the nest is held in place by the straps *T*. I regard these holes as objectionable, however, and always use the recess *R* in preference, where it is permissible. In turning out the recess, the sharp corner *U* of the pit in the die is slightly rounded and highly polished. If this is not done the gold will be scratched or even cut by the sharp corners of the flutes which are now, of course, exact duplicates of the flutes on the punch.

In making the larger sizes of crown dies it becomes necessary to turn out a pit in the top of the die, removing most of the metal in the way of the punch before beginning the operation of sinking so that the punch has only to draw up the flutes. This hole should be turned as smooth as possible, and polished. I have known a small ring made in the turning which was hardly discernible with the naked eye, to irretrievably ruin a die, for no matter to what extent the sinking was carried, that ring would still appear on the flutes, and of necessity on the finished crown. Filled gold plate consists of a very thin sheet of gold (10 or 12 carat) laid on a sheet of copper, and united by pressure alone, no solder or other adhesive being used. It will be seen, however, that all the work on a crown die using this stock must be perfect, for the slightest scratch through the thin gold will quickly show on the darker colored copper beneath, which will eventually turn a dark brown while the uninjured part of the gold will remain bright. A flute on the punch that has been slightly distorted in hardening, will sometimes draw the gold so that it will not cover the copper after the slight buffing the crowns receive as a finish, and a dark spot on the crown will soon develop in use.

Dies for small sizes of crowns are commonly made solid at the bottom of the pit, as in the die *V*, Fig. 1, but the larger sizes require some means of pushing the drawn shell out of the die. A rod *W* is used for this purpose which has a small end or shoulder as shown, which is of such a length that when the shoulder strikes the bottom of the counterbored hole in the die, and the shell is forced down into the die, the top of the crown is drawn into shape by the top end of the rod, instead of the bottom of the pit as in the small sizes. In making dies of this class, it should never be attempted to drill the central hole for the rod *W* after the die is sunk. It is my practice to drill the hole while the die is on the face-plate, and after the clearance hole is made for the punch. It should be a few drill sizes smaller than the correct finish size for the small end of the rod. The punch in sinking will fol-

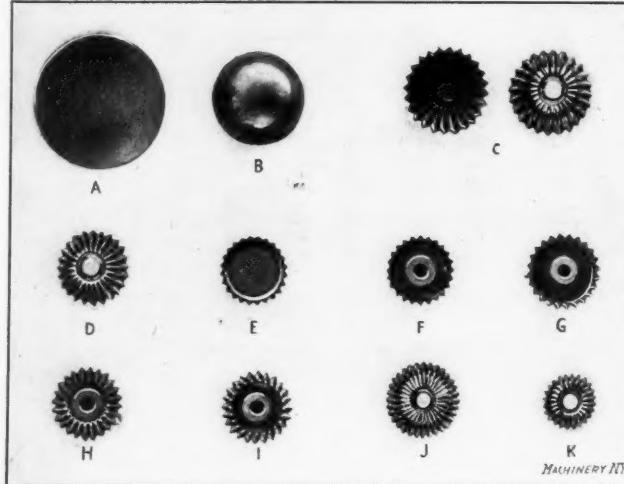


Fig. 4. The Evolution of a Watch Crown

applied at first, but the blows should be struck gently, until the point of the punch has entered the die far enough so that the flutes on the sides of the punch are well supported by the wall of the die. The greatest danger of breaking the punch is when the operation of sinking is first started, but by observing the above precaution, breakage may be reduced to a minimum. The punch should be kept wet with the solution (which is applied with a small brush) and driven a little at a time down into the die. Care should be taken to prevent dirt, bristles from the brush or other foreign matter from getting into the pit as it is being sunk, and after every two or three blows the die should be turned around. In doing this, it should be lifted by the hand from the recess in the press bed, and placed on the punch, after which the press is carefully brought down, and the die located in the recess, when the sinking may be continued. As the punch travels down, the force of the blows may be increased with safety, until the required depth is nearly reached, when they should be again moderated, and at the finish the die should only be tapped gently. The reason for this is that a large number of gently delivered blows towards the finish will make a much more durable die, and one that is less liable to crack in hardening.

If by any means one of the flutes of the punch should break in the sinking (and it sometimes happens with the most careful management) see that no small pieces of the splinter are in the die, and then, by the method of turning heretofore de-

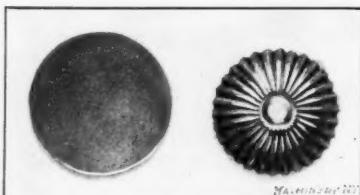


Fig. 5. Gold-filled Blank for 18-size Crown, and Shape after Second Operation

low this hole very accurately if everything else is correct, and after the die is sunk, the hole may be enlarged to the proper size for lapping to an exact fit on the rod after hardening. In the smaller sizes, the shell will come out of the die on the punch from which it may be removed with the fingers, but in the large sizes a blow from a mallet on the lever *X* is often required to force the shell out of the die. This lever is fulcrumed in the shoe *Y* which is strapped to the bed of the press, and holds the die in position under the punch. A slight tap on the lever will, through the agency of the rod *W*, drive the shell out of the die after the punch has been withdrawn.

After the die has been completed, a second working punch for drawing the shells must be made. It is in all respects like the first or sinking punch in shape, but is made smaller in diameter by twice the thickness of the stock used. This applies to both the body, and the hub which forms the top of the crown. In addition to this, a small clearance must be allowed which varies from a fraction of a thousandth of an inch to one or more thousandths, according to the size of the crown to be made. This allowance is for distortions in hardening, and other small differences between the punch, die, and stock, although the latter is usually very uniform in thickness. The round blanks are found in the market, of the correct diameters for the various sizes, and are generally bought by the manufacturers ready for use, so that the toolmaker is chiefly concerned with the various drawing processes.

The first drawing operation is to make the round blank into a shallow cup as at *B*, Fig. 4, where a cup for a 16 size crown is shown. This is done in a die that is easily made, but must, of course, be correct in size and smooth. This die is made with its punch, in the same manner as described for the fluted ones, but a little more latitude may be allowed between the punch and die so as to treat the gold blank as gently as possible. Heating between the drawing processes is never necessary if the preliminary tools are made right, as the stock will harden but slightly, before the shell reaches the fluting stage.

The second operation, *C*, puts the primary flutes in, as well as the top in a rudimentary form. The blank for an 18 size and also its shape after the second operation, is shown in Fig. 5. The punch used in forming the blank to this shape is shown to the right in Fig. 2. The third operation, *D*, brings the sides up parallel or nearly so, and to the correct diameter of the finished crown. The punch for this operation is shown to the left in Fig. 2. In small work, operation number two is omitted, and the shell is drawn directly from a plain shallow cup to the shape shown at *D*.

After the third operation, the shell is ready to receive the hub in which is tapped the thread for the stem. This hub is made from a chunk of soft brass which is chopped off in almost any old way. It is thrown into a die that forms it as shown at *E*, with the same number of flutes as the shell. The top is smaller than the top of the shell, but exactly fills it. The making of the punch for sinking this die is the same as for the other fluted punches, but it is slightly smaller than the inside diameter of the shell so that the hub may be pushed into the shell without stretching it. After the die is finished, a second punch is made with a blunt end somewhat smaller than the inside of the die at the top. This outfit is used commonly on a foot-press that is operated with great spirit by one of the small jokers of the establishment, who turns the hubs out by the thousand at so much per.

After the hub is struck up, it is put into a spring chuck, counterbored, drilled, and tapped for the stem of the watch as at *F*. It is then pushed into the shell by the aforesaid small joker, as at *G*, and it is then ready to close in, which requires a special punch and die, as shown in Fig. 6. This die is made so that by changing the rod *W*, a number of different sizes may be closed by the same die. The punch as well as the die is sunk, which is done as follows: The shank *L* having been duly turned, the body *M* is bored out to the proper taper and a smaller straight hole is bored as shown. The sinking punch *O* has the same number of flutes in it, and is as carefully made as the shell punch so that the flutes in the taper will be absolutely smooth, and of a high polish. At its point it is provided with a pilot that fits the straight hole in the punch *M*. The punch *M* is placed in an inverted posi-

tion in a special shoe on the screw-press, and the flutes sunk in it by the punch *O*, which is attached to the press plunger.

After both punch and die are finished, the shell of the crown containing the brass hub is placed top side down in the die, and the punch *M* is brought down on it until it strikes the die. This action draws the top together, as shown at *H* (Fig. 4), and brings the crown to the shape required for brazing, which consists essentially in counterboring the ragged edges where the brass hub and shell come together, to the correct size to fit the watch case. Samples of the completed crowns, antique style, are shown at *I*, *J* and *K*, the first two being number 16 in size and the last number 12.

After the dies are made, and are ready to be hardened, the pit is filled with a stiff paste of lampblack mixed with the non-sealing solution mentioned in this article. The die is now luted into a hardening box, and brought to a low red heat, and allowed to cool off over night. Unless this precaution is taken, the great molecular strain set up in the top of the die blank by the sinking, is liable to cause it to split in the hardening. When the die is finally ready to be hardened the pit is again filled with the lampblack mixture, and the die is packed in the same manner as heretofore described for hardening the punches, and then heated to the proper temperature to dip.

The hardening bath is sometimes of oil, but I prefer clean rain water which has been made lukewarm. The die is taken quickly from the box, and dipped face down into the cup *C* (Fig. 7) of the hardening tank. Holes are cored out in this cup so as to allow a free circulation of the water, and to per-

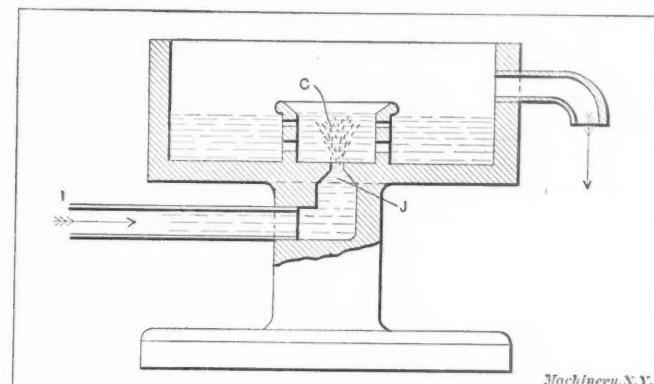


Fig. 7. Tank in which the Crown Dies are hardened

mit the steam to escape readily. Water is let into the cup until it is about half full, and then the die is placed therein; the water which is supplied by a pump at about 15 pounds pressure, is then turned on full.

The jet *J* comes directly under the sunk pit in the die, and quickly washes out the lampblack, driving it with the steam through the holes in the side of the cup. If the dies are of the proper temperature, it will be found that the flutes and bottom of the pit that forms the top of the crown, are perfectly hardened, smooth, and almost as bright as when put in the hardening box.

Both the punches and dies for making watch crowns, should be so smooth and bright as to reflect any article brought near them like a mirror, and if in this condition they will turn out perfect work.

* * *

EXPLODED BOILER PROJECTED TO GREAT HEIGHT

A 400 H. P. vertical water-tube boiler of the type having water and steam drums connected by the water tubes, exploded in the Denver Gas & Electric Co.'s power plant in Denver, Col., last June. The bottom head of the lower drum ruptured at the rivet holes where connected to the shell, and the boiler "sky-rocketed" to a calculated height of over 1,600 feet; it fell into the engine room 175 feet from its starting point and demolished a Hamilton-Corliss engine and two large direct-connected generators. The explosion caused the immediate death of four persons and serious injuries to four others. The estimate of the damage to property ranged from \$60,000 to \$200,000. The explosion and calculations of the height to which the boiler projected itself were the subjects of an interesting article in the July number of the *Locomotive*.

ACCURATE SETTING OF THE BEVEL GEAR CUTTER*

WARREN E. THOMPSON;

This article deals exclusively with the formed bevel gear rotary cutter, and introduces a method of mathematically finding the correct setting of the bevel gear cutter in relation to the axis of the gear; also the amount of rotation of the gear blank required for the correct thickness of the teeth.

Bevel gear cutting with a formed cutter is but a compromise process, the teeth having to be shaped, to a certain extent, after cutting by filing or other means.

The customary practice is to cut the large end of the tooth to the correct form as nearly as possible and then finish the small end addendum by rounding, either with a file or by running it in mesh with a hardened master gear. Another method is to cut the large end of the tooth slightly more rounding than necessary and the small end of the space deeper than regularly figured. The latter method saves considerable of the after finishing work and if the teeth are cut somewhat thin, an amount varying with the pitch, they may be run with no other labor on them, but will be noisy at high speed. These two methods of producing bevel gears with rotary cutters are the most economical of the many available, but the first produces the most nearly correct tooth form of any.

The following methods of obtaining settings are applicable to all methods of cutting with rotary cutters whether in the milling machine or gear cutter, but, of course, allowances must be made in the formulas for conditions other than those described:

The Choice of the Cutter

The choice of the cutter is perhaps the most important item of any, as the smoothness of the tooth action is entirely dependent upon the shape of the formed cutter. The best method for selection of the cutter, in the writer's opinion, is to figure or measure the back cone radius of the gear, and multiply it by twice the given diametral pitch. This gives the number of teeth of an equivalent spur gear having the correct tooth form. The position of the cutter in relation to the axis of the gear is variable with each case, and this is what makes the selection of the cutter a rather difficult proposition. Select a spur gear cutter for the calculated spur gear, and scribe the outline of the tooth form on a piece of blackened zinc or other sheet metal. Select a bevel gear cutter having the same or slightly less concave form. This method has been used by the writer and found more satisfactory than any other coming within his experience. [Of course the tooth faces of the spur cutter and bevel cutter must be ground exactly radial and parallel with the cutter axis, as they should properly be, in order to make the comparison effective.—EDITOR.]

The Setting of the Cutter

The setting of the cutter has been a matter of cut-and-try and a rather unsatisfactory operation as well as costly in high-

* For further information on this subject, see "Cutting Bevel Gears with a Rotary Cutter," October, 1907, and "Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-over," in this issue.

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grade labor. The following method overcomes these difficulties to a marked degree; it enables the draftsman to put the figures for the shop on the gear drawings the same as other shop data:

Fig. 1 represents the layout of the middle section of a gear tooth lying in the same plane as the axis of the gear. BT is the pitch radius; BP the front cone radius; and BR the back cone radius. AB and A_1B_1 are the addenda; BC and B_1C_1 , the working depths; and BD and B_1D_1 the whole depths of space below the pitch line, called the $S + F$ and $s + F$ of the large and small ends of the tooth respectively. BB_1 is the

BEVEL GEAR CUTTER PROPORTIONS, 1 DIAMETRAL PITCH

Cutter No. 1, 135 Teeth	Cutter No. 2, 55 Teeth	Cutter No. 3, 35 Teeth	Cutter No. 4, 26 Teeth	Cutter No. 5, 21 Teeth	Cutter No. 6, 17 Teeth	Cutter No. 7, 14 Teeth	Cutter No. 8, 12 Teeth				
$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t
1.152 .000	1.146 .000	1.1395 .000	1.133 .000	1.128 .000	1.121 .000	1.113 .000	1.106 .000	1.096 .013	1.099 .013	1.099 .013	1.099 .013
1.145 .006	1.139 .006	1.132 .008	1.126 .008	1.121 .008	1.114 .010	1.106 .012	1.099 .017	1.092 .019	1.092 .019	1.092 .019	1.092 .019
1.138 .010	1.132 .009	1.125 .013	1.119 .013	1.114 .010	1.107 .017	1.100 .022	1.092 .021	1.085 .025	1.085 .025	1.085 .025	1.085 .025
1.131 .014	1.125 .012	1.118 .019	1.112 .018	1.107 .014	1.100 .023	1.093 .027	1.085 .025	1.078 .031	1.078 .031	1.078 .031	1.078 .031
1.124 .018	1.118 .016	1.111 .022	1.105 .022	1.100 .023	1.093 .027	1.086 .032	1.078 .030	1.071 .037	1.071 .037	1.071 .037	1.071 .037
1.117 .022	1.111 .022	1.104 .026	1.098 .027	1.093 .027	1.086 .030	1.079 .040	1.071 .035	1.064 .042	1.064 .042	1.064 .042	1.064 .042
1.110 .026	1.104 .026	1.097 .029	1.091 .032	1.086 .030	1.079 .040	1.072 .045	1.064 .040	1.057 .047	1.057 .047	1.057 .047	1.057 .047
1.103 .030	1.097 .029	1.090 .033	1.084 .036	1.079 .036	1.072 .045	1.065 .048	1.057 .045	1.050 .052	1.050 .052	1.050 .052	1.050 .052
1.096 .034	1.090 .034	1.083 .040	1.077 .040	1.072 .040	1.065 .048	1.057 .045	1.050 .050	1.043 .056	1.043 .056	1.043 .056	1.043 .056
1.089 .040	1.083 .038	1.076 .042	1.070 .044	1.065 .044	1.058 .050	1.050 .050	1.043 .058	1.036 .060	1.036 .060	1.036 .060	1.036 .060
1.082 .044	1.076 .042	1.069 .044	1.063 .048	1.058 .048	1.051 .057	1.043 .058	1.036 .057	1.029 .064	1.029 .064	1.029 .064	1.029 .064
1.075 .048	1.069 .044	1.062 .047	1.056 .052	1.051 .052	1.044 .060	1.036 .057	1.029 .062	1.022 .067	1.022 .067	1.022 .067	1.022 .067
1.068 .052	1.062 .048	1.055 .050	1.049 .055	1.044 .058	1.037 .063	1.029 .063	1.022 .068	1.015 .070	1.015 .070	1.015 .070	1.015 .070
1.061 .056	1.055 .052	1.048 .056	1.042 .058	1.037 .064	1.030 .068	1.022 .068	1.015 .070	1.008 .074	1.008 .074	1.008 .074	1.008 .074
1.054 .059	1.048 .056	1.041 .060	1.035 .062	1.030 .068	1.023 .070	1.016 .075	1.008 .075	1.001 .080	1.001 .080	1.001 .080	1.001 .080
1.047 .062	1.041 .059	1.034 .065	1.028 .066	1.023 .070	1.016 .074	1.009 .080	1.001 .080	994 .080	994 .080	994 .080	994 .080
1.040 .066	1.034 .062	1.027 .068	1.021 .071	1.016 .074	1.009 .080	1.002 .085	.994 .085	.987 .088	.987 .088	.987 .088	.987 .088
1.033 .070	1.027 .068	1.020 .072	1.014 .075	1.009 .078	1.002 .084	.995 .090	.987 .090	.980 .090	.980 .090	.980 .090	.980 .090
1.026 .074	1.020 .072	1.013 .076	1.007 .079	1.002 .084	.995 .090	.987 .090	.980 .093	.973 .094	.973 .094	.973 .094	.973 .094
1.019 .076	1.013 .074	1.006 .079	1.000 .082	.995 .086	.988 .093	.980 .093	.973 .098	.966 .097	.966 .097	.966 .097	.966 .097
1.012 .080	1.006 .078	.999 .082	.993 .085	.988 .090	.981 .098	.973 .098	.966 .100	.959 .100	.959 .100	.959 .100	.959 .100
1.005 .084	.999 .082	.992 .086	.986 .089	.981 .094	.974 .100	.966 .103	.959 .105	.952 .108	.952 .108	.952 .108	.952 .108
.998 .088	.992 .086	.985 .089	.979 .092	.974 .100	.967 .103	.959 .105	.952 .108	.945 .110	.945 .110	.945 .110	.945 .110
.991 .092	.985 .090	.978 .092	.972 .096	.967 .104	.960 .108	.952 .110	.945 .116	.938 .119	.938 .119	.938 .119	.938 .119
.984 .094	.978 .094	.971 .096	.965 .100	.960 .108	.953 .113	.945 .115	.938 .116	.931 .112	.931 .112	.931 .112	.931 .112
.977 .098	.971 .098	.964 .100	.958 .104	.953 .112	.946 .115	.938 .116	.931 .117	.924 .115	.924 .115	.924 .115	.924 .115
.970 .100	.964 .100	.957 .104	.951 .107	.946 .116	.939 .118	.932 .120	.924 .122	.917 .125	.917 .125	.917 .125	.917 .125
.963 .104	.957 .104	.950 .108	.944 .111	.939 .118	.932 .120	.925 .123	.917 .125	.910 .121	.910 .121	.910 .121	.910 .121
.956 .110	.950 .108	.943 .111	.937 .115	.932 .122	.925 .123	.918 .125	.910 .126	.903 .124	.903 .124	.903 .124	.903 .124
.949 .114	.943 .112	.936 .115	.930 .118	.925 .124	.918 .125	.910 .126	.903 .127	.896 .127	.896 .127	.896 .127	.896 .127
.942 .116	.936 .116	.929 .120	.923 .121	.918 .126	.911 .128	.904 .129	.896 .130	.889 .130	.889 .130	.889 .130	.889 .130
.935 .120	.929 .120	.922 .124	.916 .126	.911 .130	.904 .129	.896 .130	.889 .135	.882 .131	.882 .131	.882 .131	.882 .131
.928 .124	.922 .124	.915 .128	.909 .130	.904 .132	.897 .134	.890 .138	.882 .136	.875 .139	.875 .139	.875 .139	.875 .139
.921 .128	.915 .128	.908 .132	.902 .133	.897 .136	.890 .138	.882 .138	.875 .140	.868 .133	.868 .133	.868 .133	.868 .133
.914 .130	.908 .130	.901 .135	.895 .136	.890 .140	.883 .144	.876 .140	.868 .139	.861 .140	.861 .140	.861 .140	.861 .140
.907 .132	.901 .133	.894 .137	.888 .140	.881 .144	.876 .148	.869 .143	.861 .145	.854 .135	.854 .135	.854 .135	.854 .135
.900 .136	.894 .136	.887 .140	.881 .144	.876 .148	.869 .150	.862 .145	.854 .142	.847 .145	.847 .145	.847 .145	.847 .145
.893 .139	.887 .139	.880 .144	.874 .148	.869 .150	.862 .152	.855 .146	.847 .145	.840 .147	.840 .147	.840 .147	.840 .147
.886 .144	.880 .142	.873 .149	.867 .152	.862 .152	.855 .146	.847 .145	.840 .147	.833 .140	.833 .140	.833 .140	.833 .140
.879 .149	.873 .146	.866 .153	.860 .154	.855 .154	.848 .147	.840 .147	.833 .150	.826 .142	.826 .142	.826 .142	.826 .142
.872 .153	.866 .149	.859 .156	.853 .156	.848 .160	.841 .148	.834 .150	.826 .151	.819 .145	.819 .145	.819 .145	.819 .145
.865 .156	.859 .152	.852 .158	.846 .159	.841 .164	.834 .150	.827 .153	.819 .153	.812 .147	.812 .147	.812 .147	.812 .147
.858 .160	.852 .157	.845 .160	.839 .162	.834 .166	.827 .153	.819 .153	.812 .155	.805 .150	.805 .150	.805 .150	.805 .150
.851 .162	.845 .161	.838 .164	.832 .166	.827 .168	.820 .155	.812 .155	.805 .155	.798 .154	.798 .154	.798 .154	.798 .154
.844 .166	.838 .165	.831 .167	.825 .169	.820 .170	.813 .157	.805 .158	.798 .159	.791 .156	.791 .156	.791 .156	.791 .156
.837 .170	.831 .169	.824 .170	.818 .172	.813 .174	.806 .158	.798 .159	.791 .160	.784 .157	.784 .157	.784 .157	.784 .157
.830 .174	.824 .172	.817 .174	.811 .174	.806 .186	.799 .160	.791 .160	.784 .157	.777 .158	.777 .158	.777 .158	.777 .158
.823 .176	.817 .174	.810 .177	.804 .176	.798 .178	.792 .161	.784 .161	.777 .163	.770 .160	.770 .160	.770 .160	.770 .160
.816 .178	.810 .176	.803 .180	.797 .179	.791 .180	.785 .163	.777 .163	.770 .165	.763 .162	.763 .162	.763 .162	.763 .162
.809 .182	.803 .180	.796 .184	.790 .182	.784 .182	.778 .164	.770 .165	.763 .166	.756 .163	.756 .163	.756 .163	.756 .163
.802 .186	.796 .185	.789 .185	.783 .186	.777 .184	.771 .165	.763 .166	.756 .169	.749 .165	.749 .165	.749 .165	.749 .165
.795 .190	.789 .188	.782 .188	.776 .190</td								

cutter only, and starts at T_c or the pitch line of the cutter; hence the $S + F$ of the actual case must be multiplied by the stipulated diametral pitch before referring to the table. Under the number of the standard cutter chosen by the method just described the given $s + F$ will be found with its corresponding t , or loss in thickness. This number must be divided by the given diametral pitch to get the actual loss in thickness from the large to the small end of the actual tooth space on the cone pitch line PB .

Now a bevel gear cutter set central with the axis of the gear will cut some such lines as DE , Fig. 2, passing outside of the gear center. The finishing face of the cutter must be moved until it cuts cone pitch lines passing through the center as FO . The angle subtended by the pitch points of the

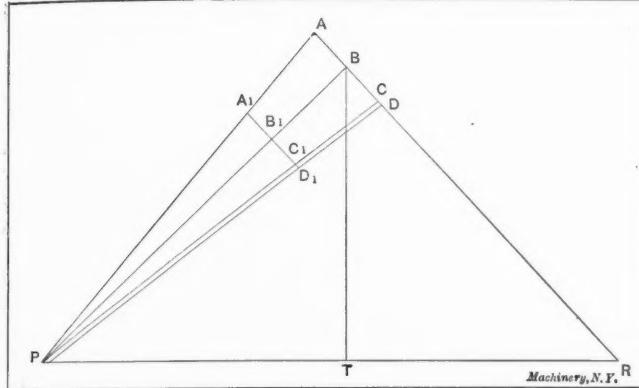


Fig. 1

cutter when it is set in its central position, measured from a line passing through the cone center parallel to the center line of the form of the cutter, is called the "cutter angle."

The tangent of this angle equals $\frac{t}{2 \text{ face}}$, or the t of the table divided by twice the length of face.

The front cone pitch line of the gear multiplied by the sine of the cutter angle equals the distance to set the pitch points of the finishing faces of cutter out of center. Call this distance D_c . To determine the required distance to move the cutter, after setting it central, the thickness of the cutter at

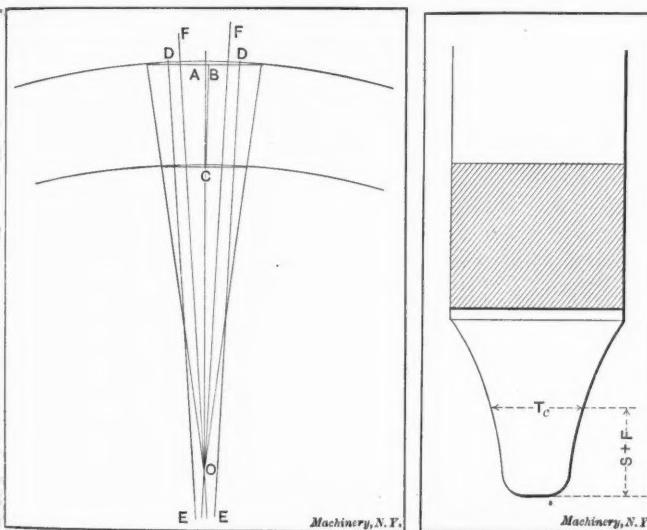


Fig. 2. Angle A1B1C1 is the "Cutter Angle"

the $S + F$ of the large end of space must be measured with the Brown & Sharpe vernier gear tooth caliper, because the cutters vary in practice. Call this thickness T_c . Subtract D_c from $\frac{T_c}{2}$, and move the finishing face of the cutter toward

the center line of the blank an amount equal to the remainder, for cutting each side of the tooth.

The table gives, in the columns headed $s + F$, the depths to which the cutter is sunk below the pitch line of the gear at the small ends of the teeth, and begins with the $s + F$ at the large ends which is measured to the pitch line T_c , Fig. 3. These depths, of course, are proportional to the length of tooth face plus the constant clearance.

$$B_1D_1 = \frac{\text{cosec. center angle} \times \frac{1}{2} \text{ pitch diam.} - \text{face}}{\text{cosec. center angle} \times \frac{1}{2} \text{ pitch diam.}} S + F$$

The values in the columns t are the differences in width of the cutter at the respective $s + F$ points, corresponding to the depth of the cutter at the cone pitch line at small end of the tooth space and the width T_c on the normal pitch line. The table being for 1 diametral pitch, the values must be divided by the diametral pitch to obtain t for other pitches.

The various operations of finding the setting may be formulated thus:

$$1. \text{ Find } \left(\frac{\frac{1}{2} \text{ pitch diam.} \times \text{cosec. center angle} - \text{face}}{\frac{1}{2} \text{ pitch diam.} \times \text{cosec. center angle}} S + F \right)$$

$\times \text{diam. pitch. } F = 0.157 \div \text{diam. pitch.}$

2. Refer to the table and find the corresponding t .

$$3. \frac{t}{\text{diam. pitch} \times 2 \text{ face}} = \text{tangent of cutter angle.}$$

4. Measure the thickness of the cutter at the $s + F$ of large end of tooth space to obtain T_c .

$$5. \frac{T_c}{2} - (\text{cone pitch line} \times \text{sine cutter angle}) = \text{the required distance to set the cutter each side of the center.}$$

The center angle is the angle included between the axis of the gear and the front cone pitch line.

These formulas are correct for both methods of cutting set forth in this article, but where the tooth is cut deeper at the small end, the $s + F$ must be figured accordingly, and this will give a small cutter angle, making the setting distance greater.

The Rotation of the Blank

The rotation of the blank may be figured by the following formula. This formula is not exact, but is very nearly so, and is used in preference to the actual true formula on account of the complications arising from the latter, making it impracticable. The vernier tooth caliper should be used to size the teeth and the blank revolved more than the formula calls for, if necessary. On small pitch gears no change from the figured rotation will be necessary unless the teeth are desired thin.

Subtract the product of twice the cone pitch line of the gear and the sine of the cutter angle from the width of the tooth space on the pitch line and divide the difference by the pitch radius to get the tangent of the angle of rotation, or,

$$6. \frac{T_c - (2 \text{ cone pitch line} \times \text{sine cutter angle})}{\text{pitch radius}} = \text{tangent of angle of rotation.}$$

Example from Practice

Bevel Gear:—16 pitch, 12 teeth, 0.75 inch pitch diameter, 0.25 inch face, 9 degrees 30 minutes, center angle, 2.272 inches cone pitch line, No. 6 cutter, $S + F = 0.069$ inch.

$$1. \left(\frac{0.375 \times 6.0588 - 0.25}{0.375 \times 6.0588} - 0.059 + 0.10 \right) \times 16 = 1.0000$$

$$2. t, \text{ from table} = 0.086$$

$$3. \frac{0.086}{16 \times 0.5} = 0.01075 \tan \text{cutter angle}; \text{ cutter angle} = 37 \text{ minutes.}$$

$$4. T_c \text{ measured} = 0.065 \text{ inch.}$$

$$5. \frac{T_c}{2} - 2.272 \times 0.01076 = 0.0081 \text{ inch.}$$

Set the cutter central, then move the finishing face 0.0081 inch toward center. Cut once around and move cutter back 0.0162 inch for the opposite side of the tooth.

$$6. \frac{0.098 - (2 \times 2.272 \times 0.01076)}{0.375} = 0.13066 \text{ tangent.}$$

Angle to revolve = 7 degrees 27 minutes.

If a dividing head having a 54-hole plate is used the blank would be given one-fortieth of a turn (one turn of the index handle) plus nine holes on the 54 circle as each hole on the circle equals 1/6 of one degree, or 10 minutes.

CLAMPING DEVICES*

LUCIEN L. HAAS†

If the reader will carefully go over the twenty illustrations of different clamping devices found in the accompanying Data Sheet, he will find that some of them are very similar; yet the mechanic will be able to cite many instances where one, and only one, of these types can be used to advantage. Of course, it will be understood that these illustrations are diagrammatical and are intended to indicate the principles of various clamping methods rather than the actual design and construction of the clamp itself. In order to make each illustration more complete, the work itself has been represented in each case by sections shown in solid black.

Figs. 1 and 2 represent the every-day method of clamping work to the table of a milling machine or to the face-plate of a lathe. The type of clamp shown in Fig. 3 is commonly used for holding work in a drill jig when one bolt or screw is sufficient, especially when it is desired to have an open end jig. Fig. 4 illustrates a scheme which is not often found in use. This type of clamp is adapted to box jigs; it has the advantage of being easily removed, which is accomplished by sliding it longitudinally. By glancing at the detailed view to the right, which shows the end of the clamping bar and its retaining grooves, the way in which it is held in place and removed will be clearly understood. Figs. 5 and 6 show clamps which are very much alike, but as a great many mechanics use the design shown in Fig. 5, I added that of Fig. 6, as it is both simpler and two-to-one quicker, when it comes to removal. It will be noted that when the clamp is slotted as shown in the plan view of Fig. 6, that fixed studs may be used instead of the swinging bolts. As there are a great many mechanics who prefer the cam as a means of clamping, the illustration Fig. 7 is presented as a reminder of the application of this principle. As is well known a cam can be used in possibly a hundred different ways. The type shown in Fig. 8 is often found in machine shops, on milling fixtures, drill jigs, lathe fixtures, etc. The clamp and bolts can be removed by loosening the nuts and pulling out the slip washers which allow the nuts to pass through the large holes. Fig. 9 illustrates a scheme which is commonly used on milling fixtures when light milling is to be done. The design of clamp shown in Fig. 10 is not frequently seen in use as it is a scheme which a mechanic will not use if he can see another way out of it; but at times it is found almost impossible to use a clamp of any other type. Fig. 11 shows the style of clamp that is used in connection with box drill jigs when it is desired to support a part to be drilled on two points. As will be seen, these two bearing points are self-adjusting. The design of Fig. 12 is generally used when it is desired to support the work in two places in an open-end drill jig. Figs. 13 and 14 show types which are quite similar, but, as before stated, there are many cases where one type can be used to advantage and not the other. For instance, the clamp, Fig. 13, is intended for box jigs and one would not think of using the type of Fig. 14 in such a jig, because the latter is altogether too slow. However, its advantages over Fig. 13, in case it is desired to have an open end jig, are apparent. The relation of the first cost of a jig to the quantity of work to be done, is a factor which sometimes makes a jig which is not perfect from a purely mechanical standpoint, more desirable than one which represents better design but greatly increased cost. Fig. 15 shows the old hook-bolt scheme, a clamp which is found in use almost as often as that of Fig. 1. The type shown in Fig. 16 answers practically the same purpose as that of Fig. 11, and it is used on, I dare say, one-third of the drill jigs now in use. A style of clamp that is somewhat similar to the one illustrated in Fig. 4, is shown in Fig. 17. In this case, however, two clamping bolts are used and the clamp is removed from the end of the jig. This is a good, as well as a quick method, of clamping work in open-end drill jigs. Fig. 18 illustrates the use of bolts only, for holding down work. The illustration is self-explanatory. Fig. 19 shows a good design of clamp for holding work in a milling fixture. It binds the work both horizontally and vertically and "has it

all over" any other type when it can be used. The last but not the least of the clamping devices is shown in Fig. 20, which illustrates the wedge method. This is found in use in about every machine shop in the world, and its application is familiar to all mechanics.

* * *

HELICAL TIMING GEARS FOR AUTOMOBILE MOTORS

ERNEST L. SMITH*

It is a fact, becoming better known each succeeding year, that correctly cut helical gearing will run with less noise than equally well cut spur gearing. That this knowledge is not wider spread, or in fact universal at present, is due naturally to the fact that the high development of hobbing machinery and the hobbing process is comparatively recent, as it is only by this process that perfect helical teeth can be machined at low cost.

The reason that the helical tooth is quieter in action than that of the spur gear is that the angle at which this tooth is cut permits only of its gradual engagement, and as this angle is usually great enough to permit the following tooth to enter contact before the first has quite passed out of mesh, we derive what may be characterized as practically a continuous contact.

The field in which these gears have been found especially desirable is that of the timing gears for a gasoline motor, *i. e.*, the gears that drive the cam-shaft and the magneto. The service of these gears is not arduous but it is imperative that they be quiet in action at either high or low speeds, and this quality the helical tooth possesses as does no other.

Regarding the specific points to be taken care of in adopting helical gears for motor timing, the Grant-Lees Machine Co., Cleveland, Ohio, suggests as an ideal outfit the following: Crank-shaft gear, of 20-point carbon steel, with no recessing; magneto gear, carbon steel, with no hubs; idler gear, of cast iron, with no hubs; cam-shaft gear of cast iron or 20-point carbon steel.

It is suggested that no recessing be done in the steel gears, because, while lightening the motor is of undoubted importance, the amount of lightening possible here is really negligible, but the increase in cost for such recessing is not. Hubs should be avoided where possible, for the same reason of cost, as they prevent ganging the gears for cutting.

An important point, then, that should be held in mind by the engineer when designing helical gears is to produce blanks that can either be made automatically from the bar or, in case the blanks are of cast iron, a simplicity in construction should be carried out so as to allow ganging of gears and the smallest number of settings of the machine for hobbing and facing them.

Cast iron is recommended in place of the once customary bronze as it is cheaper than bronze, and for this service in no way inferior. In fact, it has this one advantage, which is of higher value than at first might appear. If a bronze gear is dropped or struck accidentally, it is liable to be harmed to an extent not noticeable on inspection, but will show up later in action. If a cast iron gear is not broken by a similar accident, it will be found as good as before.

Almost any angle of the teeth from 12 to 20 degrees will give satisfaction, as the end thrust resulting from an angle within these limits will for this service (timing gears) be slight enough to be negligible. A diametral pitch from 9 to 12 is usually employed, and approximately a one-inch face on the gear.

Although the use of helical timing gears was practically unknown four years ago, the designers of automobiles have already come to regard them highly as is shown by the fact that the Grant-Lees Machine Company will in 1909-10 cut timing gears of this type for something over 20 per cent of the American automobile manufacturers, this percentage practically covering the field.

* * *

Pure winter strained lard oil is the best lubricant for tapping, reaming and boring steel castings, and for cutting threads on wrought iron pipe.

* Address: 6901 Quincy Ave., Cleveland, Ohio.

* With Data Sheet Supplement.

† Address: 341 Landon St., Buffalo, N. Y.

ELECTRIC DRIVE OF TURBINE PUMPS*

It is becoming a well-recognized fact that the electrical engineer, in order to successfully solve the problems of his particular science, must give earnest study and work to many other branches of engineering. The peculiarities of electrical rotating machinery make it desirable, and often essential, to obtain a thorough knowledge of the mode of operation, variation of load, and nature of product, of the mechanical apparatus that it will be applied to. The point of view of the electrical engineer is in this study so different from that of the mechanical engineer in designing his part of the combination that it should cause no surprise if the investigations of the former must run along entirely original lines. Such has most prominently been the case in introducing the electric motor in steel, cotton and paper mills, or when applying gas engines to the driving of electric generators. The turbine pump, to which this paper will be devoted,

alternating current motors, this variation is generally accomplished by using a different number of poles for the two speeds.

At each constant speed, however, it will be found that most pump manufacturers are by no means certain as to how the load on any particular pump varies with varying head. Neither do they seem to think accurate information in this respect of special value. A glance at the accompanying diagram, which shows a typical relation between head, capacity, efficiency and brake horse-power in ordinary commercial turbine pumps demonstrates the great importance to the electrical engineer of obtaining a similar diagram or equivalent information wherever he undertakes to prescribe the size of the motor. In this diagram an efficiency of 65 per cent is assumed, but the relations given will be approximately correct for all efficiencies between 50 and 80 per cent.

The pump ought to be adapted for an average head corresponding to its maximum efficiency. This head, however, will nearly always vary considerably; the water level will, for instance, rise and fall in the source of supply and in the tank or reservoir into which the water is pumped, or if the water is forced directly into a distribution system, the varying demand will frequently cause the discharge pressure to vary over a wide range. The emptying of dry-docks through turbine pumps presents a particularly interesting problem of this nature. In such cases it will be found that when the *head falls off*, the capacity generally increases, and as the efficiency at the same time goes down rapidly, the *load* in most turbine pumps *increases*. It becomes imperative, therefore, that the electrical engineer should know what this overload amounts to, within the range of abnormally low head liable to occur, and the duration of such overloads.

It is true that the pump manufacturers are beginning to realize that this characteristic of the turbine pump makes it unsuitable for electric motor drive, and that they, therefore, have endeavored, and partially succeeded, in "flattening" the capacity curve over a considerable range, thereby making the horse-power required fairly constant between the same limits; but the electrical engineer will as yet seldom meet this condition, and in any case it is safe to remember that the size of the motor is governed by capacity at low rather than at high head. Where no information in this respect is obtainable, it is safe to assume the relations shown in the diagram. On account of the efficiency in all motors, and the power factor in induction motors, being lower at lighter loads, electrical engineers should use every opportunity to impress upon pump builders the desirability of designing pumps with a horse-power curve as flat as possible.

Official test records of pumps recently furnished the U. S. Government for dry-dock purposes will soon be published, and will show that the desired constancy in load has been reached almost to perfection. In these pumps the vanes of the impellers act themselves as automatic throttles, so to speak, restricting the capacity with decreasing head so that the energy consumed is kept constant.

It is often left to the electrical engineer to determine the horse-power required by a certain pump from the capacity in gallons per minute, total head in feet or pounds pressure per square inch, and the efficiency of the pump. Frequently, however, the head given in the specifications does not include friction in the water pipes. It is necessary, of course, to make allowance for this factor when calculating the horse-power of the motor. For the convenience of the electrical engineer who meets this problem, the accompanying table is here given, showing the friction head in feet per hundred feet commercial pipe sizes and for different capacities. The number of U. S. gallons delivered per minute multiplied by 8.3 gives the pounds of water handled per minute. This product multiplied by the sum of the total vertical head and total friction head taken from the table gives foot-pounds work done per minute. If the head is stated as composed of suction lift and pounds of pressure delivered by the pump, it is only necessary to remember that each pound corresponds to 2.3 feet static head. As one horse-power is equivalent to raising 33,000 pounds one foot in one minute against the force of gravity, we obtain the work done in the pump expressed in horse-power by dividing the foot-pounds just calculated by 33,000. This

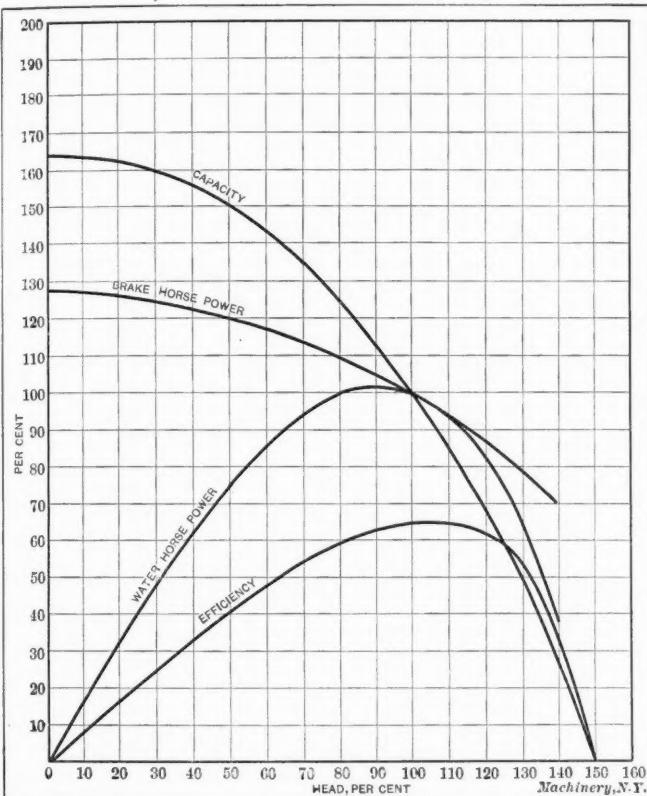


Diagram showing the Relation between Capacity, Brake Horse-power, Water Horse-power, and Efficiency of Centrifugal Pumps running at Constant Speed

has been comparatively neglected, and yet the erratic conditions found in many pump installations show the unquestionable necessity for a better understanding of the problem involved in electric drive of turbine pumps.

The troubles experienced indicate that there are two principal questions, the correct solution of which insure successful electrical operation of turbine pumps. First, the selection of the proper size of motor to take care of varying load conditions; second, the selection of the proper type of motor to meet different starting requirements.

Taking these questions in the order just mentioned, it first becomes necessary to investigate how the load on a turbine pump running at constant speed or nearly so, varies with varying capacity and head. The variation of the load with different speeds is less important and less involved. It is less important, because at each speed that may be desired our reasoning for constant speed is applicable. It is less involved, because the behavior of the turbine pump in this respect is well known, and all necessary information is voluntarily and fairly accurately supplied by the pump manufacturer. The self-evident necessity of allowing margin in the motor for different speeds has caused this condition to be well taken care of. The most frequent speed variation desired is one speed for so-called domestic service pressure and another for fire service pressure. In the case of multipolar

*Abstract of a paper by Mr. J. E. Fries, read before the American Society of Swedish Engineers, at Brooklyn, N. Y., October 16, 1909.

result is often called "water horse-power." A final division by the efficiency of the pump gives effective horse-power required from the motor. The suction lift and the friction head in the suction pipe added together must, of course, be kept as far below the theoretical limit of 32 feet as possible.

The second consideration that must be given serious thought when attempting electric drive of turbine pumps is that of starting. The direct-current motors possess such remarkable qualities in this respect that little difficulties are to be anticipated in their application to turbine pumps, provided they have the proper capacity to handle the load under all other conditions. The great majority of electrically-driven centrifugal pumps are, however, supplied with alternating current. An induction motor of sufficient capacity to handle the expected load will also start the pump successfully, provided the current rush is tolerated. A synchronous motor, on the other hand, may or may not start the pump, the torque of the motor, especially with certain designs, being very small until synchronism is reached, while the torque required by the pump grows with the square of the velocity. Just before

the water boiling hot. The only way to partially relieve the load from a primed pump is to close a valve in the discharge pipe and open an outlet between this valve and the pump, thus discharging close to the pump and letting the water go to waste during the period of starting. In the case of a single-stage pump, however, the capacity is much greater at the lower head, and the load may even be more than normal, as pointed out before, but with multi-stage pumps the water passages through the pump do not allow such great increase of water flow as would correspond to the extremely low head, and although it might be thought that the excess energy would be converted into heat, practice shows that the load on the motor is in this way partly relieved.

It is evident from the foregoing that the synchronous motor of ordinary design when applied to turbine pumps may fail to pull into synchronism. As the starting torque in a synchronous motor is due to eddy currents and hysteresis, and more to the former than to the latter, it follows that every means to increase the eddy currents improve the possibility of starting a turbine pump. Thus solid steel poles are far superior to

FRICITION OF WATER IN PIPES

Friction loss in feet static head, for each 100 feet of length in different sizes of clean iron pipes discharging given quantities of water per minute

Gals. per Min.	Size of Pipe, Inside Diameter, in Inches														
	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	18
5	7.6	1.94	0.72	0.28	...	...	...	...	...	...	...	...	...	...	...
10	30.0	7.3	2.42	1.09	0.28	...	...	...	...	...	...	...	...	...	...
15	66.3	16.1	5.5	2.24	0.44	...	...	...	...	...	...	...	...	...	...
20	116.0	28.4	9.4	3.8	0.97	...	...	...	...	...	...	...	...	...	...
25	180.0	44.0	28.6	6.1	1.48	0.49	0.23	...	...	...	...	...	...	...	...
30	...	63.5	37.2	8.7	2.1	0.69	0.32	...	...	...	...	...	...	...	...
35	...	85.5	46.7	11.7	2.9	0.78	0.35	...	...	...	...	...	...	...	...
40	...	111.0	57.5	15.1	3.7	1.21	0.53	...	...	...	...	...	...	...	...
45	...	130.0	18.8	4.6	1.52	0.66	...	...	...	...	...	...	...	...	...
50	23.1	5.6	1.87	0.81	0.21	...	...	...	...	...	...	...	...
75	51.8	12.3	4.15	1.71	0.37	...	...	...	...	...	...	...	...
100	90.0	21.9	7.4	3.03	0.76	0.12	...	...	...	...	...	...	...
125	34.5	11.3	4.6	1.14	0.17	...	...	...	...	...	...	...
150	49.0	16.2	6.6	1.60	0.23	...	...	...	...	...	...	...
175	65.0	21.9	8.9	2.16	0.30	...	...	...	...	...	...	...
200	86.7	28.8	11.6	2.82	0.39	...	...	...	...	...	...	...
250	45.4	17.9	4.37	0.60	0.16	0.07	0.02	...	...	...	...	...
300	64.8	25.9	6.87	0.86	0.21	0.09	0.03	...	...	...	...	...
350	35.2	8.43	1.15	0.28	0.12	0.05	...	...	...	...	...
400	45.0	11.0	1.50	0.37	0.14	0.06	...	...	...	...	...
450	57.8	13.9	1.87	0.46	0.16	0.07	...	...	...	...	...
500	71.2	17.2	2.22	0.58	0.25	0.09	0.039	0.021	0.012	...	...
750	5.10	1.23	0.42	0.19	0.068	0.039	0.035	...	...	...
1000	8.95	2.17	0.74	0.30	0.14	0.083	0.093	...	...	...
1250	3.37	1.13	0.46	0.22	0.12	0.11	...	...	...
1500	4.83	1.62	0.67	0.31	0.16	0.13	...	...	...
1750	2.20	0.88	0.41	0.21	0.14	...	...	...
2000	2.84	1.13	0.54	0.28	0.16	...	...	...
2250	1.45	0.68	0.36	0.20	...	...	...
2500	1.78	0.84	0.44	0.25	...	...	...
3000	2.56	1.19	0.62	0.35	...	...	...
3500	1.61	0.85	0.47	...	...	...
4000	2.10	1.09	0.61	...	...	...
4500	1.27	0.77	...	...	...
5000	1.69	0.95	...	...	...

synchronism, therefore, is the critical point in starting turbine pumps. The best remedy for this trouble, as well as for excessive starting currents, is to start the pump empty and prime it after full speed has been reached. Where water is not delivered to the pump under pressure, this may be accomplished either by an auxiliary pump of the rotary type, or an ejector where steam is available, in both cases forcing the supply of water up the suction pipe into the pump.

The electrical engineer is often told that although the pump is filled with water, it will start under very light load, because a check valve will be closed either in the suction or in the discharge pipe, and the writer has seen similar statements in specifications issued by consulting engineers of very good standing. The truth is, however, that neither of these expedients improve starting conditions at all. With the valve closed in the suction line, the pump supports the ordinary water column just the same, and with the valve closed in the discharge line, the pump creates a pressure behind the valve, so that in either case the load is practically normal, and the energy consumed is transformed into heat, which soon makes

laminated ones. Some manufacturers provide copper rings around the pole tips for the same purpose. A radical, although expensive, method of improving the laminated pole motor, is to provide it with a squirrel-cage winding in the pole faces, thus approximating induction motor starting characteristics. Owing to the big air gap and consequent leakage and also to the uneven distribution of this secondary winding, the torque is far from that of an induction motor.

It seems that where synchronous motors are desired the best solution is to prime after starting. It would also seem, however, that where high starting currents are not objectionable, sufficient starting torque may be obtained in synchronous motors with inherent low starting torque, without the highly expensive squirrel-cage winding, by supplying a starting compensator capable of producing about 25 per cent excess voltage. As the torque increases with the square of the voltage, this means should in most cases prove sufficient. Precautions must be taken, however, to make the change from one voltage to another gradual and not sudden, so as not to overstrain the windings.

METHODS AND TOOLS USED IN METAL SPINNING

C. TUELLS

Metal spinning, that process of sheet metal goods manufacturing which deals with the forming of sheet metal into circular shapes of great variety by means of the lathe, forms and hand-tools, is full of kinks and schemes peculiar to itself. It is the purpose of this article to give a description of spinning in general, and to outline some of the methods and tools used in spinning for rapid production.

The products of metal spinning are used in a great many lines of manufacture. Examples of this work are chandelier parts, cooking utensils, silver and britannia hollow-ware, automobile lamps, cane-heads and many other sheet metal specialties. Brass, copper, zinc, aluminum, iron, soft steel, and, in fact nearly all metals yield readily to the spinner's skill. At best spinning is physically hard work, and the softer the stock, the easier and quicker the spinner can transform it into the required product.

There are but two practical ways of forming pieces of sheet metal into hollow circular articles: by dies and by spinning. By far the cheapest and best method of producing quantities of this class of work is by the use of dies, but there are many cases where it is impractical or impossible to follow this course. Dies are expensive and there is constant danger of breakage, whereas spinning forms are easily and cheaply

qualities), allowing the use of four or five different speeds. Speed is an important factor in spinning. Arbitrary rules for spinning speeds cannot be given, as the thicker the stock the slower must be the speed; thus while 1/32-inch iron can be readily spun at 600 revolutions, 1/16-inch iron would necessitate reducing the speed to 400 revolutions per minute. Zinc spins best at from 1,000 to 1,400 revolutions; copper works well at 800 to 1,000; brass and aluminum require practically the same speed, from 800 to 1,200; while the comparatively slow speed of 300 to 600 revolutions is effective on iron and soft steel. Britannia and silver spin best at speeds from 800 to 1,000 revolutions.

One of the essential parts of the spinning lathe is the T-rest. The base of this rest is movable on the ways of the lathe, and it has at the side nearest the operator, a stud about four inches in diameter and six inches high, through which is swiveled the T-rest proper. As the illustration shows, provision is made for raising and lowering the rest, and the entire rest may be clamped in any desired position by means of the hand-wheel shown beneath the ways. The rest proper consists of an arm, 12 to 15 inches long, similar to a wood turner's rest, and through the face of this arm are from twelve to sixteen closely spaced $\frac{3}{8}$ -inch holes. These holes are to receive the pin against which the hand tools are held while spinning. The pin is three inches long and of $\frac{3}{4}$ -inch steel, turned down on one end to loosely fit the holes in the rest.

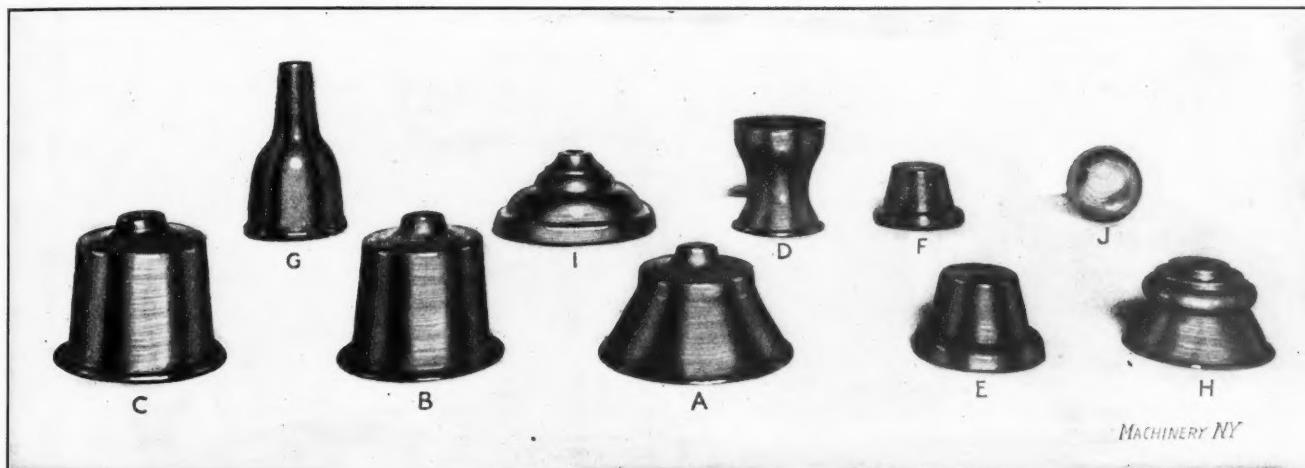


Fig. 1. Specimens of Metal Spinning

made and are almost never damaged by use beyond a reasonable amount of wear. Thus it will be seen that when the production is small, it does not pay to make costly dies. Again, the styles or designs of many articles that are spun are constantly being changed; if made by dies each change would necessitate a new die, while in spinning merely a new wooden form is required—and sometimes the old form can be altered, costing practically nothing. Still other advantages of spinning are that in working soft steel, a much cheaper grade may be spun than can be drawn with dies; beads may be rolled at the edges of shells at little expense; experimental pieces may be made quickly, and, added to these features, comes the fact that very difficult work that cannot possibly be made with dies can be spun with comparative ease. It must not be construed from the above that spinning is to be preferred to die work in all or even in the majority of cases, because, on the contrary, die work is a more economical method of manufacture, and should always be used when possible on production work. The cases already cited are merely given to point out some of the instances in which, for economical reasons, spinning is to be preferred to die work.

The Spinning Lathe

The principal tool used in the operation of spinning is the spinning lathe, shown in Fig. 2. While in many respects this machine is similar to any other lathe, it is built without back-gears, carriage or lead-screw, is very rigid in construction, and, on the whole, very much resembles a speed lathe. Like other lathes, the spinning lathe is fitted with a cone pulley (preferably of wood, because of its lightness and gripping

Another important part of the spinning lathe is the tail-center. This center is sometimes the ordinary dead center that is in general machine shop use, but nearly all spinners use the revolving center, shown in Fig. 3. The revolving center is $\frac{3}{4}$ inch diameter (without taper) and about six inches long, and is fitted into the socket in which it runs; this socket is, in turn, fitted to the taper hole in the tailstock. At the bottom of the hole in the socket are two steel buttons, hardened and ground convex on their faces. These buttons act as ball bearings and reduce friction to a minimum.

Forms and Chucks for Spinning

The shape of a shell made by spinning is dependent on the form or chuck upon which the metal is spun. Forms are used for plain spinning where the shape of the shell will permit of its being readily taken from the form after the spinning has been completed; but when the shape of the shell is such that it will not "draw," as the molders say, it becomes necessary to employ sectional chucks, similar to the one shown in Fig. 5. Generally speaking, spinning forms are made of kiln dried maple. After being bored and threaded to fit the lathe spindle, the spinner turns the maple block to agree with a templet shaped in outline to the sample shell. When no sample is furnished, the templet must be laid out from the sketch or drawing; in either case proper allowance is made for the thickness of the stock. When large quantities of shells are to be spun, all alike, the form is sometimes made of lignum vitæ. Another method is to turn the maple form small enough so that one shell may be spun and cemented to it and then this metal-cased form is used to spin the balance of the shells.

For continuous spinning, forms are made of cast iron or steel, which of course makes a most satisfactory surface to spin on and gives indefinite service.

A sectional or "split" chuck, as it is sometimes called, is, as the name implies, a spinning chuck or form which may be taken apart in sections after the shell has been spun over it. As before stated, this class of spinning chuck is only used when the finished shell could not be removed from an ordinary form after spinning. After a shell has been spun over a sectional chuck, the shell and the sections of the chuck are together pulled lengthwise from the core of the chuck. Then, starting with the key section, it is an easy matter to remove each section from the inside of the shell. As the sections are removed, they are replaced upon the core, slipped under the

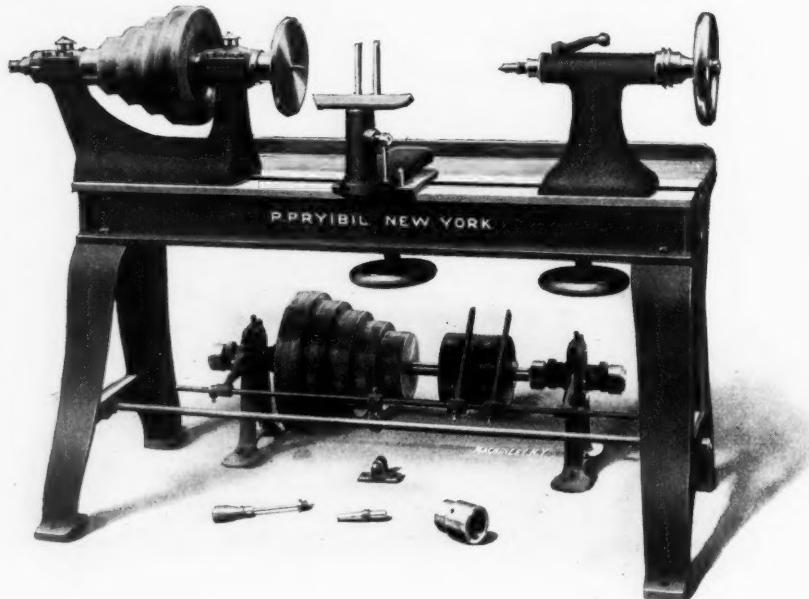


Fig. 2. Spinning Lathe

retaining flange and the chuck is ready for spinning a new shell. The whole operation of removing and replacing the sections of a chuck takes less time than it does to tell it, and, as the sections are of different sizes, it is easy to replace them in the proper order. Like other forms, sectional chucks are made of wood or metal, according to the requirements of the job. The core and retaining ring are first made from one piece and then the sections are turned in a continuous ring and split with a fine saw. In some cases it is necessary to add a small piece to the last section to make up for the stock lost in splitting the sections.

Another kind of sectional chuck, known to the trade as a "plug" (shown in Fig. 7) is used extensively in some shops in cases where the shell must have projections or shoulders at both ends, and no bottom to the shell is required. In making the plug, which is always in two parts, the first half is turned to take the shell from one end to the center of the smallest diameter. Into the end of this part is bored a hole to which is fitted the end of the second part, which is afterwards turned to fit the shell. Over this two-part plug the shell is spun; then the bottom of the shell is cut out and the first half of the plug removed thus allowing the shell to be withdrawn. The first part is then replaced and the plug is ready for use again. Fig. 6 shows a method of spinning difficult shells that ordinarily would require a sectional chuck. The shell shown at the left of Fig. 6 is first spun as far as the bulged part on an ordinary form that ends at this point. Then after annealing, it is replaced on the form and while another operator holds the wooden arm, supported with a pin in the T-rest, the spinner forms the metal around the bulge-shaped end of the arm. The arm, being stationary on the inside of the shell, acts as a continuation of the spinning form, and by this method as good a shell is obtained as could be spun with a sectional chuck.

For spinning operations upon tubing or press-drawn tubes, steel arbors are generally used. Tubing may be readily spun

upon an arbor and it can be reduced or expanded to comply with the shape of shell required much more quickly than the shell could be spun from the blank.

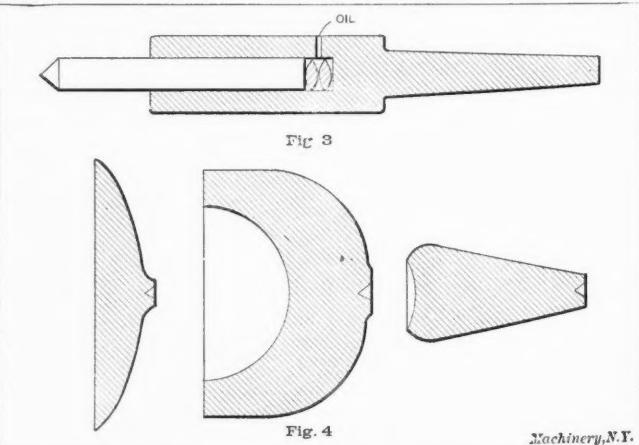
Followers

For holding the sheet metal blank to the spinning form, a block of wood known as the follower, is used (see Fig. 4). Followers are made to suit the shape of the work with which they are to be employed, always being made with the largest possible bearing on the work; thus a shell with a flat bottom twelve inches in diameter would be turned with the aid of a follower having an 11 $\frac{3}{4}$ -inch face; while a shell with a 4-inch face would take a follower with a 3 $\frac{1}{2}$ -inch face. All shells do not have flat bottoms, consequently, in spinning such as do not, it becomes necessary to employ hollow followers. Hollow followers have their bearing surfaces turned out to fit the ends of the forms with which they are to be used. In practice, the blank is held against the end of the spherical form with a small flat follower until enough of the shell has been spun to admit of the hollow follower being used. All followers are made with a large center hole in one end to receive the revolving tail-center.

In starting to spin a difficult shell it sometimes happens that the necessarily small follower will not hold the blank. To prevent this slipping, the face of the follower is covered with emery cloth. Often, however, on rough work, the spinner will not stop to face the follower, but will make a large shallow dent at the center of the blank; the extra pressure required to force the metal against the form will usually overcome the slipping tendency.

Hand Tools

Hand tools, in great variety, form the principal asset of the spinner's kit. Spinning tools are made of tool steel forged to the required shapes, and are hardened and polished on the "business" end. The round steel from which they are made varies from $\frac{1}{2}$ inch to 1 $\frac{1}{2}$ inch in diameter, according to the class of work upon which they are to be used. The length of a spinning tool is about 2 feet, and it is fitted into a wooden handle 2 inches diameter and 18 inches long, making the total length of the handled tool about 3 feet, as shown in Fig. 8. As the spinner holds this handle under the right armpit, he



Figs. 3 and 4. Revolving Center and Three Types of Followers

secures a great leverage upon the work and is better able to supply the physical power required to bring the metal to the desired shape.

The commonest and by far the most useful of the spinning tools is the combination "point and ball" which together with a number of other tools, is shown in Fig. 10. This tool is used in doing the bulk of the spinning operations—for starting the work and bringing it approximately to the shape of the form. Its range of usefulness is large on account of the many differ-

ent shapes that may be utilized by merely turning the tool in a different direction. Next in importance comes the flat or smoothing tool which, as the name implies, is for smoothing the shell and finishing any rough surfaces left by the point and ball tool. The fishtail tool, so named from its shape, is used principally in flaring the end of a shell from the inside, "spinning on air" as it is sometimes termed. This tool is used to good advantage in any place where it is necessary to stretch the metal to any extent, and its thin rounding edge proves useful in setting the metal into corners and narrow grooves. Other tools are the ball tool which is adapted to finishing curves; the hook tool, used on inside work; and the beading tool which is needed in rolling over a bead at the edge of a shell when extra strength or a better finish is desired.

When much beading of one kind is being done, a large heavy pair of round-nose pliers (Fig. 11) with the jaws bent around

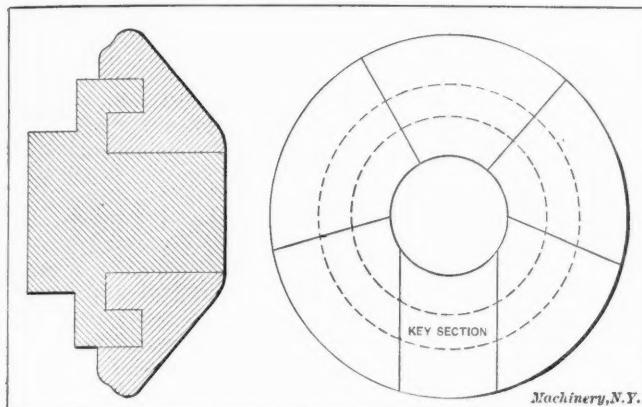
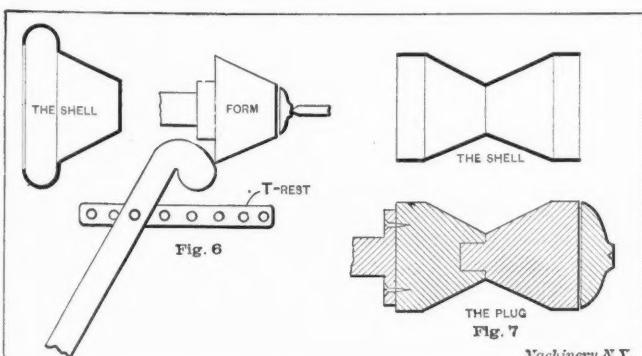


Fig. 5. Sectional Spinning Chuck

in a curve and sprung apart enough to allow for the thickness of the metal proves to be a handy tool. After the edge of the shell has been flared out to start the bead, the pliers are opened enough to admit the metal and then closed and the stock guided around to form the bead as far as possible. In this way the larger part of a bead is rapidly formed; one jaw of the plier acting as a spinning tool and the other corresponding to the back-stick. During this operation, the pliers are, of course, supported by being held against the T-rest.

Closely allied with these spinning tools are two other tools (also shown in Fig. 10) known as the diamond point and the skimmer. The diamond point is for trimming the edges of the shell during the spinning operation and for cutting out centers or other parts of the work. The skimmer is for cleaning up the surface of a shell, removing a small amount of metal in doing so, the amount depending upon the skill the spinner used in the spinning proper.

When the bottoms are to be cut from a large number of shells and it is necessary that they be cut exactly alike, a tool



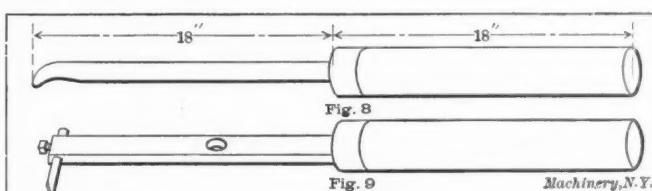
Figs. 6 and 7. Quick Method of Spinning Difficult Shell without Sectional Chuck, and Spinning on Plugs

known as a swivel cutter is used. This tool (see Fig. 9) is simply an iron bar with a cutter on one end, which swivels near the center around a pin in the T-rest; thus by a slight movement of the arm the cutter is brought up to the work, cutting a piece from the shell of exactly the same size each time.

The Spinning Operation

In order to make clear the successive steps in spinning, let us briefly consider the making of a copper head-light reflector, and the way the work is handled when a few hundred pieces are to be made.

By trial spinning, the size of the blank required for one of the reflectors is determined, and with the square shears the



Figs. 8 and 9. Handled Spinning Tool and Swivel Cutter

copper sheets are cut into pieces an eighth of an inch larger each way. These squares are then taken to the circular shears and cut to round shapes ready for the spinning lathe. The spinning form, of kiln dried maple, is screwed to the spindle and the belt thrown to that step of the cone pulley which will bring the speed nearest to 1,200 revolutions. From the stock room a follower is selected whose face will nearly cover the bottom of the form. It is now "up to" the spinner. Holding a blank and also the follower against the end of the form, he runs the tail-center up to the center in the follower just hard enough to hold the blank in place. Then, starting the lathe, he centers the blank by lightly pressing against its edge a hard wood stick. As soon as it "lines up" he runs the center up a little harder and clamps it in place. Some spinners will "hop in" a blank with the lathe running, but this is dangerous

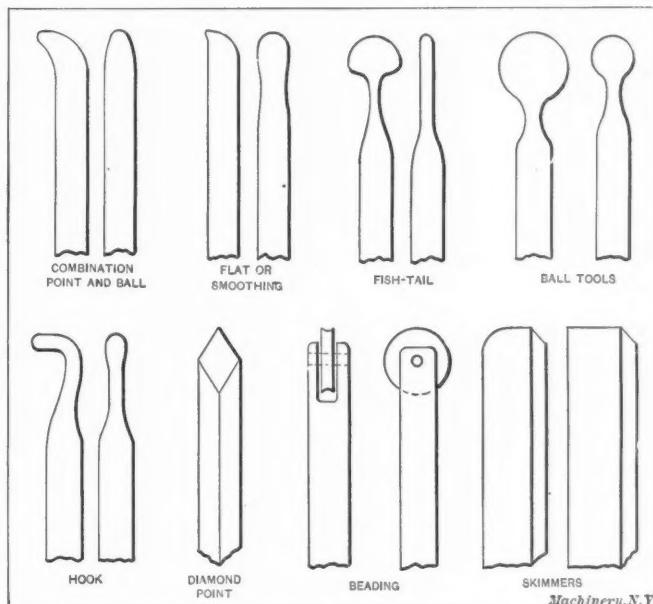


Fig. 10. Hand Tools of Various Forms used in Spinning

practice and sometimes the blank will go sailing across the room. Often this happens in truing up the blank and for this reason it is considered advisable to have a wire grating at the further side of the lathe to prevent serious accidents; for a sheet metal blank is a dangerous missile traveling at the high rate of speed which is imparted to it by the lathe.

With a piece of beeswax (soap is sometimes used for economical reasons) the spinner lightly rubs the rapidly revolving blank and then adjusts the pin in the T-rest to a point near enough to the blank to obtain a good leverage with the spinning tool. Holding the handle of his point and ball tool under his right armpit and using the tool as a lever and the pin on the rest as a fulcrum, he slowly forces the metal disk back in the direction of the body of the form; never allowing the tool to rest in one spot, but constantly working it in and out, applying the pressure on the way out to the edge of the disk and letting up as he comes back for a new stroke. In the meantime his left hand is busy holding a short piece of hard wood (called the back-stick), firmly against the revers-

side of the metal at a constantly changing point opposite the tool. The object of the back-stick is to keep the stock from wrinkling as it is stretched toward the edge of the disk. Wrinkles cause the metal to crack at the edges and for this reason they must be kept from the stock as much as possible.

After a few strokes of the spinning tool have been taken, the shell will appear about as shown at *B*, Fig. 12, and at this point, it is necessary to trim the shell at the edges with the diamond-point tool. Trimming is required because spinning stretches the stock and the resulting uneven edge will cause splits in the metal if it is not trimmed occasionally. As a carpenter is known by his chips, so a spinner is known by the way his work stretches. While the even pressure of a good spinner will stretch the stock very little, the uneven pressure of the inexperienced man will lead him into all sorts of trouble

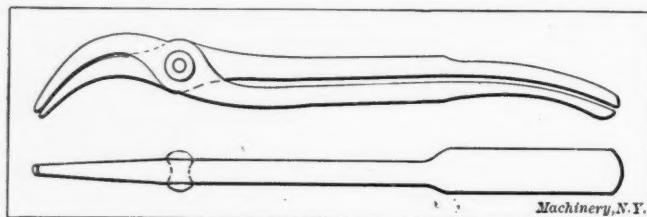


Fig. 11. Spinner's Pliers

on account of the way the stock will go. In either case the metal always stretches least in the direction in which the sheet stock was originally rolled, consequently giving the edge a slight oval shape. In trimming zinc, the spinner holds a "swab" of cloth just above the diamond point, to prevent the chips from flying into his face and eyes—or those of his neighbors. With other metals the swab is unnecessary.

The reflector is now taking shape. With each successive stroke the spinner sets a little more of the metal against the form. Not only does spinning stretch the metal, but it hardens it as well; therefore, at the stage *C* it becomes necessary to anneal the partially completed reflector, which is done by heating it to a low red in a gas furnace. In running through a lot of shells, the common practice is to spin them all as far as possible without annealing and after annealing the whole lot, to complete the spinning.

After replacing the shell upon the form, it is trimmed and worked further along the form, gradually assuming the ap-

pearance shown at *D*. At this time, the spinner goes back to the small radius at the front end of the shell and with a ball tool he closes the annealed metal hard down against the form, for the spinning has tended to pull the stock slightly from the form at this point. The body of the reflector is now practically completed and the spinner directs his attention to rolling the bead at the outside edge. Slowly he begins to roll the edge of the shell back, using his hook tool to complete the bead as far as possible and exercising care to keep the back-stick firmly against the metal so as to keep the wrinkles out.

Now, with the diamond point, he gives the edges a final trim and with the beading tool closes down the bead snugly against the rest of the shell, as shown at *E*. Lastly, the swivel cutter is placed in the proper hole of the T-rest and a turn of the tool cuts out the center to the exact size, and the reflector is completed. If any burrs or rough places remain they are easily removed at this time with the skimmer or diamond point and a little emery cloth gives the shell a finished appearance.

Referring to the illustration Fig. 1, *A*, *B* and *C* represent the three most important stages of spinning a shell like that shown at *C*. Annealing is necessary between steps *A* and *B*. *D* is a shell spun upon a form of the plug variety, and *E* and *F* are two views of a shell spun after the method shown in Fig. 6, *F* being the completed shell. *G* illustrates a very difficult shell to spin, on account of the small follower that must be used; the length of the small diameter also adds to the difficulty. *H* shows a shell that must be spun upon a sectional chuck, while *I* is a plain easy job of ornamental spinning. The ball shown at *J* was spun from one piece of aluminum and it is more of a curiosity than a specimen of practical spinning. It was first spun over a form that would leave one-half of the ball complete and the stock for the other half straight out like a short tube. Next a wooden split chuck was made, hollowed out to receive the finished end of the ball and the open end was gradually spun down and in until the ball was complete with but a 1/16-inch hole at the finish. This hole was plugged and the hollow ball was done.

While the operation of spinning is a comparatively simple one to describe, it is not easily learned, and to-day good all-around spinners are hard to find. The limits of accuracy are not as closely defined as in straight machine work, but there are times when good fits are absolutely necessary, as in cases where two shells must slip snugly together. In this article we have taken up only the plain every-day kind of spinning, and were we to follow its work in the gold and silversmith's trade, we would see it evolve into a fine art. In order to insure really good work coming from the spinning lathe, there is a wide range of knowledge that the spinner must have. That knowledge may be brought together and summed up by a single word—*judgment*.

A STEAM BOILER INCIDENT

Seventeen years ago an enterprising farmer living near Boston purchased a portable steam pump to water his farm. Every summer he has had one of the young men in the neighborhood run it, under the supervision of Mike, the foreman, whose word was law. This summer the boiler leaked so badly that the facts came to my attention. The boiler tubes became so overheated and loosened that there was not a single one which was tight. In former years when they leaked badly, Mike, with a hammer and chisel, would calk them until they were fairly tight. Several years ago the steam gage was stolen, and since that time the "engineer" estimated the pressure by the rate the pump worked with the throttle wide open. How he estimated it when the pump was not working was not made clear to me. The water used in the boiler was the same as that used in the pump, and it came from a dirty frog pond. Small fish and eel grass were continually thrown out of the discharge nozzle of the pump and the natural inference was that they were just as frequently thrown into the boiler. The water glass was so dirty that even if there had been any water in it it could not have been seen; as Mike explained, "It was so stuck up with mud that you couldn't ever depend on it."

Once (long ago) Mike opened a hand hole to clean out the boiler, but as he said, "there was such a mess in there that it would have taken a whole day to clean it out, and what was the use, since it was running all right as it was"—and the mud stayed in there. In all these seventeen years no repairs have been made to the boiler, it has never been inspected, the inside has never been cleaned, its safety valve and steam gage (when it had one) have never been tested, and it has never had anyone with a license to run it. In spite of all this, the owner refuses to have any repairs made, saying that "it isn't worth it, and as long as it will pump water, let it alone and don't fool with it."

E. M. S.

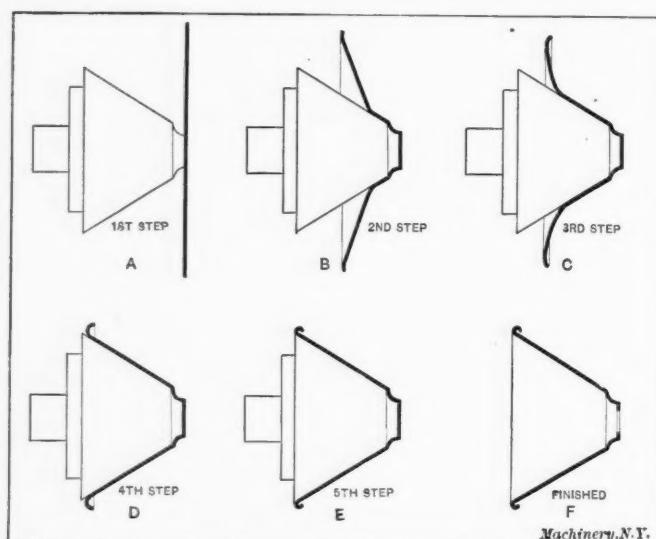


Fig. 12. Successive Steps in Spinning a Reflector

pearance shown at *D*. At this time, the spinner goes back to the small radius at the front end of the shell and with a ball tool he closes the annealed metal hard down against the form, for the spinning has tended to pull the stock slightly from the form at this point. The body of the reflector is now practically completed and the spinner directs his attention to rolling the bead at the outside edge. Slowly he begins to roll the edge of the shell back, using his hook tool to complete the bead as far as possible and exercising care to keep the back-stick firmly against the metal so as to keep the wrinkles out.

MANUFACTURING AUTOMOBILE EQUALIZING GEARS*

A TYPICAL EXAMPLE OF GOOD DESIGN AND SHOP PRACTICE

RALPH E. FLANDERS†

There is always some question in the mind of the editor as to the interest of his readers in descriptions of typical shop operations. There are occasional operations of particular interest owing to the accuracy required, the novel principles employed, or unusual difficulties to be overcome; about such material there is no doubt. This present article, on the other hand, deals with operations which do not present these unusual or spectacular features, yet the writer feels that they have a value derived from the fact that they are closely related to the operations which produce the bulk of the product of the machine shops of the country; for that reason they should attract the attention of mechanics interested in accurate and economical work. In the particular case with which this article deals, we are able to describe and adequately illustrate the operations from beginning to end, for making a complete, compact machine unit—a differential or equalizing gear for automobile use. The completeness of the job gives it a suggestive value that would not be offered by a series of miscellaneous operations, however interesting. The value of this description, however, does not depend on its completeness

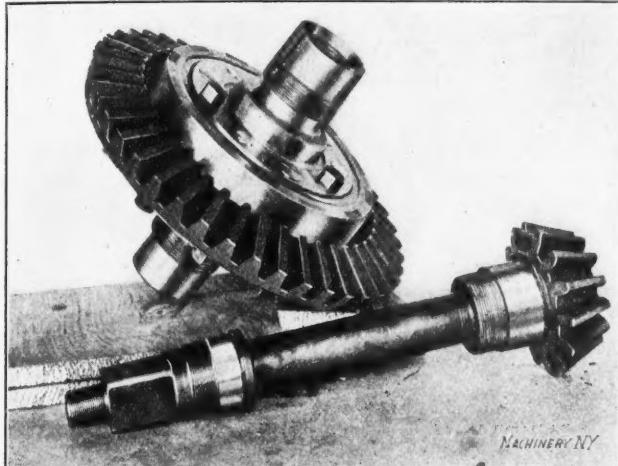


Fig. 1. The Equalizing Gear Complete, with Bevel Gear and Pinion, as used in the Stevens-Duryea Automobile.

alone, as many of the specific shop operations give evidence of a high degree of manufacturing ability.

Description of the Equalizing Gear

Figs. 1, 2 and 3 show assembled, dismantled and detail views, respectively, of an equalizing or differential gear, designed by Mr. A. A. Fuller, of the Providence Engineering Works, Providence, R. I. The determining feature of this design is the necessity for getting a maximum of strength and effectiveness in a minimum of space—coupled, of course, with reasonable cost of manufacture. This problem was attacked by scientific analysis. It was possible, without great difficulty, to obtain reasonable strength in the casing which contains the equalizing gearing. The crucial point was in the design of the equalizing gears themselves. In determining the proportions of the gears, curves were drawn showing the strength of the teeth for lay-outs of varying pitch and number of teeth, arranged to be contained within a casing of a given diameter. The strength and bearing area of the pivots, and the strength of the pinions as limited by the thickness of the shell between the bottom of the tooth and the bore, had also to be reckoned with. The tooth shapes were not confined to standard forms, but various pressure angles and heights of addendum were investigated. By comparing the curves for various possible designs, a certain pitch, number of teeth and shape of tooth for the various gears were found for each diameter of casing, so proportioned that if any of the dimensions were changed, the mechanism became weaker instead of stronger. These

*For further description of this type of differential gearing, see October number of MACHINERY, page 84, engineering edition.

†Associate Editor of MACHINERY.

proportions, worked into a design satisfactory in other particulars, have been adopted as standard, and the makers feel confident that it is impossible to enclose in the same space gears of greater strength than they are offering in the design illustrated herewith. As this confidence is based on mathematical calculations and has been further tested by many months of experience, it seems reasonable that they should hold to it.

Referring particularly to Fig. 3, the mechanism is contained within case *B* and covers *A* and *A'*. It revolves in the rear

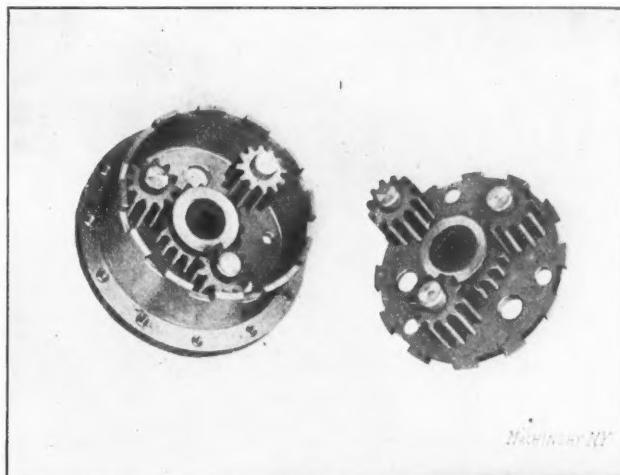


Fig. 2. A Small Size of Equalizing Gear Dismantled to show Construction

axle gear casing on ball bearings, mounted at the ends of casings *A* and *A'*, and the driving bevel gear is carried on the periphery of case *B*, to which it is clamped by hex-head screws *H*. The pivots *E* are riveted into the flanges of covers *A* and *A'*, three in one side and three in the other. These pivots carry pinions *F* and *F'* meshing with gears *C* and *C'*; the latter run in bronze bushings *D* and *D'* forced into the two covers, and are provided with broached square holes by which the floating wheel shafts are driven. As will be seen in Fig. 2 in connection with Fig. 3, gear *C* meshes with pinion *F'*, which also meshes with pinion *F*, the latter in turn engaging gear *C'*. Thus, when gear *C* is turned, gear *C'* is revolved in the opposite direction, and vice versa, thus forming a spur gear differential mechanism.

Attention may be called to some of the features which make for strength in this design. It will be seen, for instance, that

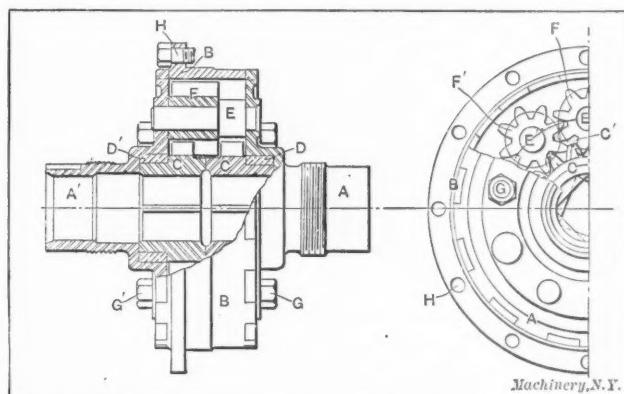


Fig. 3. Details of Construction of the 7-inch Equalizing Gear

the gears have teeth of special shape and of very coarse pitch and few numbers of teeth. The pinions have eight teeth and the gears sixteen each. In designing the mechanism by analysis, as described, it was found that this construction was necessary for strength. Older designs of this kind, more commonly met with, in which the pinions are smaller in proportion to the gears, have repeatedly proved their weakness by breakage.

Mention should also be made of the solid way in which the parts composing the casing are fastened together. The casing *B* is provided with tongues locking into the grooves cut in covers *A*, so that the strain of transmission is taken on these interlocking members and does not depend on the bolts, dowel pins or similar parts. So far as this torsional strain is con-

cerned, the casing is as strong as if it were made of solid metal—an impossible construction, of course. Through bolts and nuts *G* and *G'* clamp the whole casing firmly together.

The proper meshing of the bevel gears can be controlled by shifting the whole casing axially in its bearings. Nuts are mounted, for this purpose, one on the threaded diameter of *A* and the other at the same point on *A'*. By loosening one and tightening the other the teeth of the gears can be brought more closely into contact, or *vice versa*.

The provisions for oiling should be noted. The casing in the rear axle is provided with a bath of oil in which the bevel gears run. Three holes cut in the exterior of *B* (not shown in Fig. 2, but visible in the detail views of the operations in Fig. 4, and at the right of Fig. 5, where these holes are being drilled) admit oil from this bath into the interior spur gears. Pivots *E* and pinions *F* are grooved, as are also gears *C* and *C'*, permitting a flow of oil through the whole structure, kept in constant motion through the revolving of the parts.

In describing the manufacture of this device we will take up each part in turn. The manufacture of the bevel gears will not be described in detail, as their design is determined

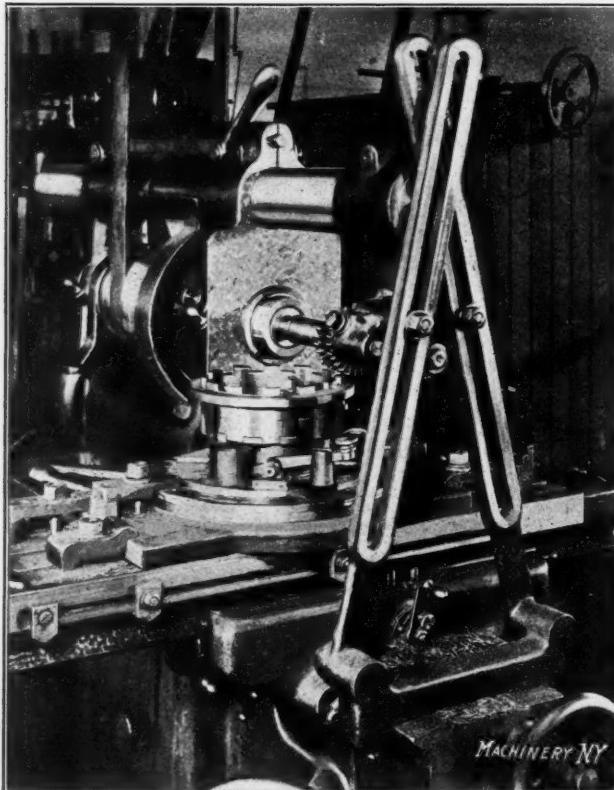


Fig. 4. Milling the Driving Tongues in the Gear Case—Second Operation

by the maker of the car in which the device is to be installed. The first part to be considered will be the gear case, shown at *B* in Fig. 3.

Operations in the Manufacture of the Gear Case

The case is made from a malleable iron casting on which the first operation, naturally, is that of snagging to remove fins, gates, etc. The second operation is performed in the Jones & Lamson flat turret lathe, of which large use is made in this shop. The casting is placed in the chuck of the machine with the flange outward. In this operation the hole is finished to size, the flange is turned, and the projecting end is faced. The regular equipment is used for this purpose, the only special tools being gages for the inside diameter of the hole and the outside diameter of the flange.

In the third operation, performed in the same machine, the part is grasped by the finished flange in special soft chuck jaws, which have been turned in place to fit the diameter they are to receive. This gives assurance that the work done in this operation will be true, within reasonable limits, with the cuts previously taken. Regular flat turret lathe equipment is used for this operation as well, suitable gages of simple construction being provided. The next operation, shown at the right of Fig. 5, is drilling the three holes which admit oil to

the interior of the case. This jig is of the simplest possible construction, consisting of a knee with a turned seat on which the work is placed, and an overhanging lug carrying a drill bushing. A clamp provides for holding the work, and a plug, entering a suitably located hole in the seat, provides means for indexing the second and third holes drilled, from the one previously completed. The other operation shown in this engraving will be described later on.

The tongues which interlock with the grooves in covers *A*, *A'* (see Fig. 3) have next to be milled. The fixture for doing this is shown in use in Fig. 4. It consists of a base provided with an index plate and a revolving table, by means of which

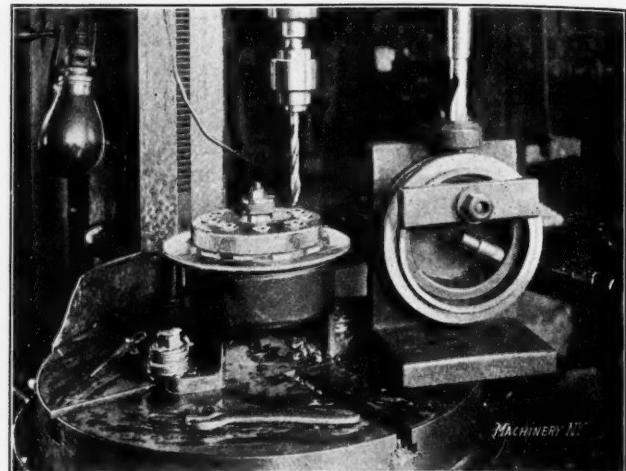


Fig. 5. Drilling the Three Oil Supply Holes in the Case (see Fixture at the Right), and Drilling the Bolt and Pivot Holes in the Cover

the work may be indexed step by step to cut the various tongues. These are shaped by straddle mills which form the opposite sides of the tongues parallel, so that they fit into corresponding grooves milled into the covers by a straight-sided cutter. In the operation illustrated, tongues have been cut on one side of the casing, which is located in its seat in the fixture by the interlocking of these tongues with grooves provided to receive them as shown. This assures alignment of the cuts on each edge of the case. In the first operation the uncut edge of the work is simply set down onto this seat. It is held down by three clamps, provided with noses which enter

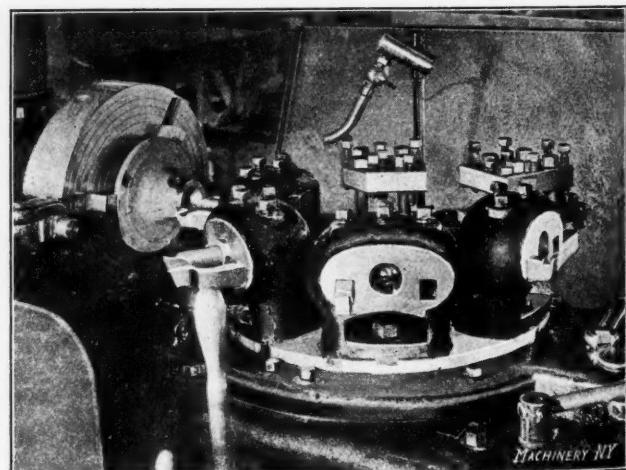


Fig. 6. The First Turret Lathe Operation in Finishing the Gear Case Covers

the three holes drilled to admit oil to the interior of the mechanism.

It is interesting to see the expertness with which the operator cuts out these tongues. The automatic feed is set at the highest point practicable when cutting the full depth. As this would be less than the maximum possible when the cutter is entering the work, he begins with a hand-feed at a considerably higher rate, throwing in the automatic feed when the cutter gets down to work. Although the machine is of modern construction, the workman was feeding it all the belt could handle, and was evidently then not satisfied with its performance, as he was engaged in tightening up both the counter-shaft and driving belts during the time of the writer's visit.

The gear casing is now complete except for certain operations performed on it in assembling, as described later.

Operations on the Gear Case Cover

The gear case covers are made from machine steel drop forgings. After the snagging, the first operation is the simple one of putting a 1½-inch hole through the center of the forgings. This is a drill press operation and is merely done to remove stock, it being, of course, impracticable to form the hole in the forging. It is next clamped by the rim with the

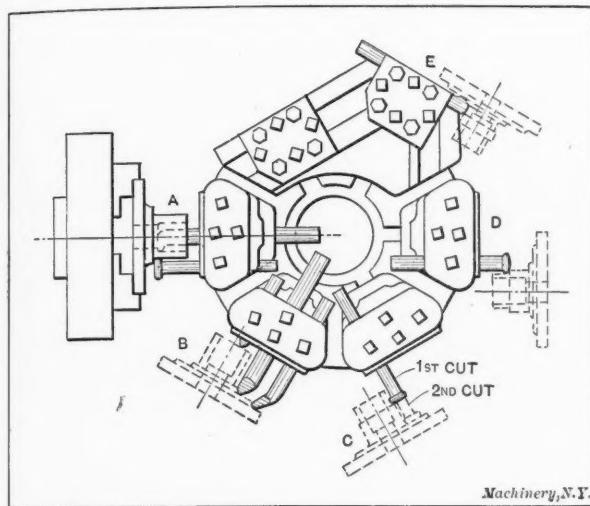


Fig. 7. Lay-out of Tools on the Flat Turret Lathe for the Operation shown in Fig. 6

hub projecting, in the chuck of the flat turret lathe. This first turret lathe operation is shown in Figs. 6 and 7, the latter diagram indicating the arrangement of the tools.

The first cut is shown at A. An outside turning and boring tool, acting in conjunction, rough turns the hub and rough bores the hole. At the next station, B, three tools simultaneously face the end of the hub and the two surfaces of the flange. Two cuts are taken with these, one for roughing and one for finishing. A third cut is taken with the same tools fed axially against the work to form the two grooves in the face of the flange, as most plainly shown in Fig. 3. At the third station C, another turning tool removes the stock on two diameters of the hub, two cuts being taken. At D a finishing cut is taken over the smaller diameter, while at E a form tool

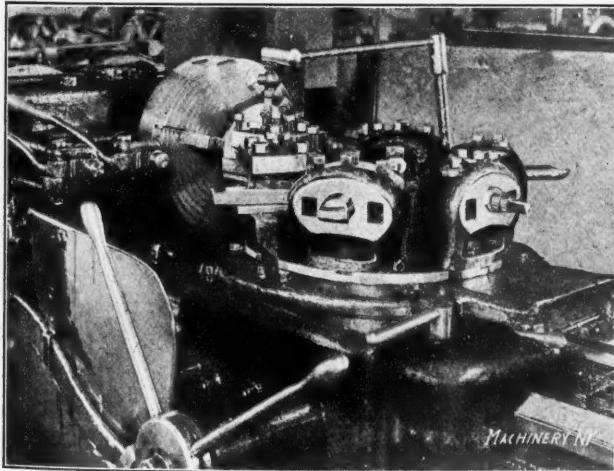


Fig. 8. Second Operation on the Flat Turret Lathe, using Special Jaws

shapes that portion of the hub extending from the threaded diameter to the flange. This operation is completed in about 18 minutes.

In the second operation (see Figs. 8 and 9) the completed end of the piece is grasped in soft jaws turned to fit the surface they grasp, assuring true running of the surfaces made in the two operations. The tool at A bores out the large diameter of the hole, which is for clearance only. The reamer at B finishes the small diameter to size. The tool at C faces the flange, taking two cuts, one to rough out stock and the second to bring it to size. A flat-nosed tool at D finishes the flange. The tool at E roughs out the counterbore, while that at F fin-

ishes it. This latter tool is fed directly in, boring the diameter of the counterbore to size until the bottom is reached, when the sliding head is fed outward, so that the same tool faces the bottom of the counterbore. The finishing is thus done by turning cuts instead of forming cuts, giving a higher degree of accuracy. Work of this kind shows the flat turret lathe to very good advantage. In the lay-out of tools shown in Figs. 7 and 9, there were probably no special tools of any kind required, with the exception of the form tool E, the rest being stock turning tools of the kind which forms the regular equipment of the machine. It may have been necessary in some cases to give the tool a knock of the hammer on the blacksmith's anvil to crook it in one direction or the other, but nothing more would be needed. The cross sliding head and the multiple stops come into play in such operations as those at B and C in Fig. 7, and F in Fig. 9, giving each separate tool a wide range of usefulness, especially when it is so made that it can be used for both turning and facing jobs.

Hand vs. Automatic Machines

Of course there are all sorts of opinions about such matters, but in the question of hand versus automatic machines, this company believes that the conditions favor the use of the hand turret lathe in its work. The simplicity of the tooling is an important factor on contract work. The management can never be sure of the long continuance of any job, so that anything approaching costliness or elabora-

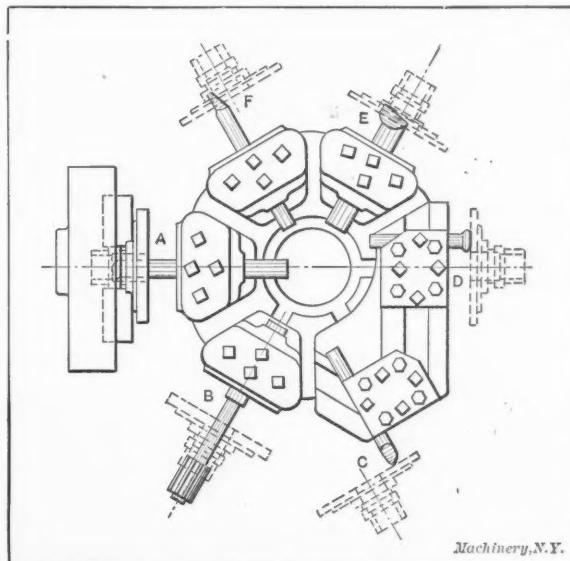


Fig. 9. Lay-out of Tools in the Operation shown in Fig. 8

tion is prohibited. Furthermore, it is reasonably certain that one hand machine will turn out more work than one automatic, particularly when, as in this shop, there is an inducement, such as the premium system, for the workman to get the most possible out of his machine. He is constantly changing his feeds and speeds as the varying diameters, depths of the cut and condition of the tool require. He is thus able to take heavier cuts without injuring his cutting edges than would be possible without constant personal supervision. Probably three or four changes are made in each operation to one that would be made by an automatic machine. As another advantage, this greater production of the machine means a much less capital outlay per dollar of output.

It certainly does keep the operator busy to get the most out of one of these lathes. There is no possibility of his running more than one machine, on this particular work at least. Cuts are taken very rapidly and changes of feed and speed follow each other in constant succession. There is a line of demarcation at the point where the intensity of production on the part of the hand machine and the lower capital charge on machines, buildings, stock, etc., balance the higher output per man and the consequent lessened labor cost for the automatic machines. In accordance with their judgment, some shop managers will draw the line at one point and some at another. It is fortunate for the builders of both types that all men do not come to the same conclusion when reasoning from the same premises.

Gear Case Covers—Continued

In Fig. 10 the milling machine is shown rigged up to cut the driving slots in a pair of the gear case covers. The two are mounted together face to face on a special iron arbor, having a driving tail cast integrally with it in place of the usual separate dog. A formed cutter is used which shapes the bottom of the slot to the true radius of the inside diameter of the casing *B* (see Figs. 3 and 4) assuring a tight fit. This operation and that shown in Fig. 4 have to be done to close limits with good indexing plates, only 0.001 inch variation being allowed on the thickness of the slot and the tongue. This means that in order to make a good fit the dividing must be very accurate. In the cases the writer saw assembled, these parts drove together with a very little gentle urging from a lead hammer. Not much of anything else seemed to be required. In Fig. 11 is shown a jig for drilling the bolt and pivot holes in the gear covers. It is of simple construction, the cover being supported on four legs and located by a central spindle over which it is dropped and by which it is clamped, an open side collar and nut being used as shown. The bushing plate set over the work is located to bring the

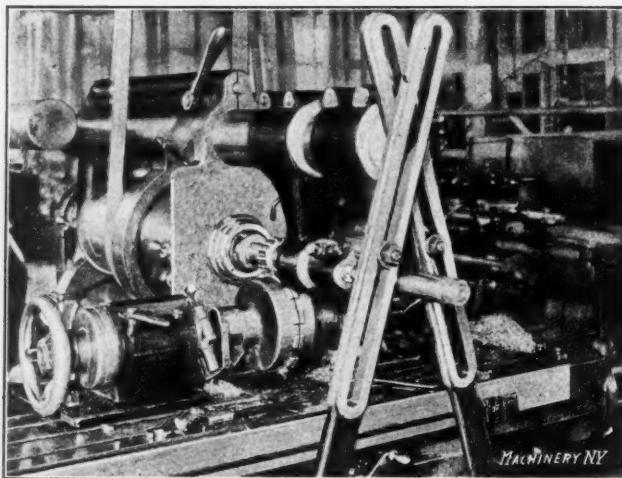


Fig. 10. Milling the Driving Slots in a Pair of Gear Case Covers

holes in right relation with the slots, by a tongue entering the latter. In the next operation the covers are mounted on a special face-plate, as shown in Fig. 12. This face-plate is surfaced true in place and is provided with an expansion mandrel centered integrally with it. The gear case is slipped on over this mandrel and tightened in place by turning on a wedge screw. While thus held the countersink in the outer end of the hub, the seat for the ball bearing, and the threaded diameter are turned. The thread is also cut. This is done by the Rivett-Dock threading tool, shown in operation.

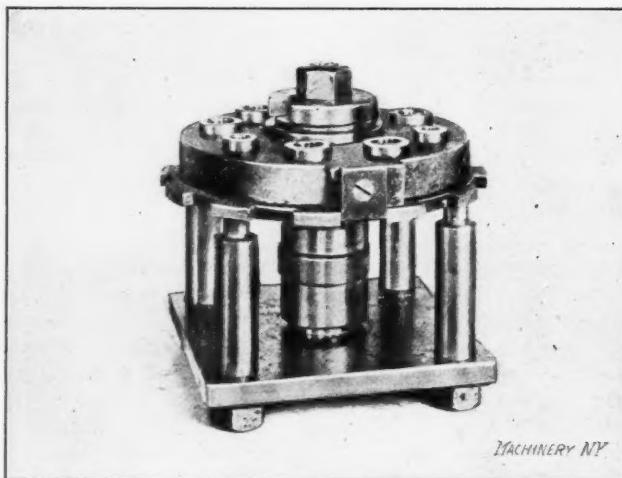


Fig. 11. Jig for Drilling the Bolt and Pivot Holes in the Gear Case Covers. Another Jig for the Same Operation is shown at the Left of Fig. 5

operations of countersinking, turning and threading, altogether, average about eight minutes time for each piece. When the turning was in progress, the writer timed the lathe and found it was making 250 revolutions per minute, which gives about 150 surface feet per minute for the cutting speed.

MACHINERY

A fixture and mill of obvious construction are used for cutting the keyway by which the inner race of the ball bearing is made fast to the hub.

Equalizing Pinions, Studs and Gears

The studs *E* are made on the Gridley automatic turret lathe with the regular tools and equipment, the job being, of course, one of the everyday variety for this machine. Oil grooves are milled, and then the burrs are removed by hand. The

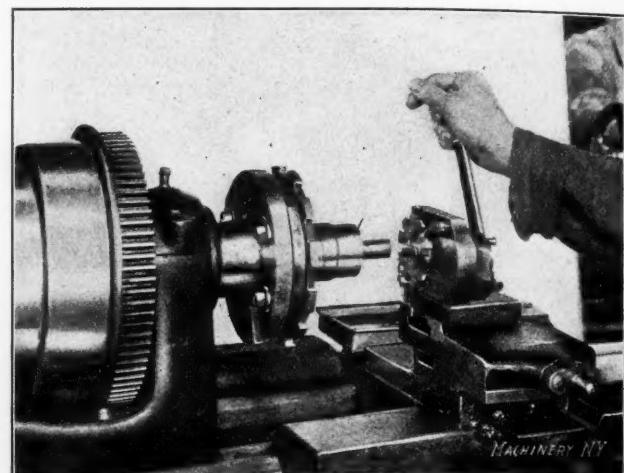


Fig. 12. Threading the Gear Case Covers with a Rivett-Dock Threading Tool equalizing pinions are drilled, reamed and turned on the flat turret lathe. The ends are squared accurately to length in the engine lathe.

The equalizing gears are cut off to length from the bar stock (all gears and pinions are made of chrome nickel steel) and are bored, reamed, faced and filleted at the large end in the Jones & Lamson machine. The hole is reamed accurately to size so as to furnish a guide for the broach in forming a square hole. This is done on the La Pointe machine at a

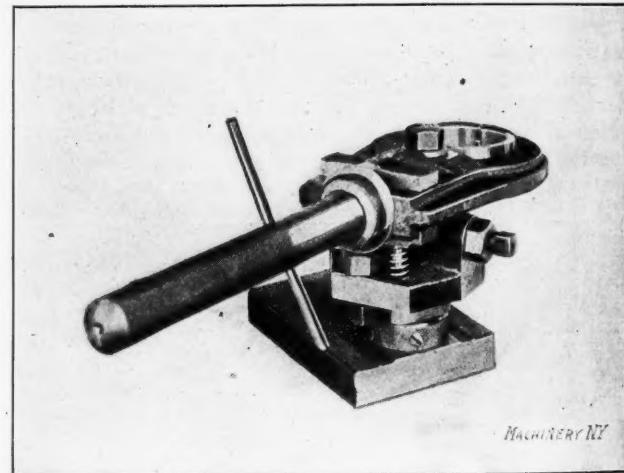


Fig. 13. A Special Fixture for Cutting Oil Grooves in the Equalizing Gear Bushing

single pass of the broach, which is a long one, having some 24 inches or thereabouts of cutting length. The outside surfaces of the gear are then rough turned on a square expansion chuck somewhat similar to that shown in Fig. 12 for the gear case cover, except, of course, that it is mounted on a square surface instead of a round one. In the next operation it is finish turned all over.

The spur gears and pinions are cut in a triple head indexing device which is one of the standard attachments on the Brown & Sharpe milling machine. Three cutters operate on three gangs of work simultaneously. By giving special shapes to the gears and by being very careful both in centering the cutters and setting them to the proper depth, first-class results have been obtained—better than are needed in fact, since normally these gears are stationary or nearly so, being in operation only when rounding corners, in the case of a deflated tire on one side, or the slipping of a wheel in the mud. After removing the burrs by file and reamer, the gears and pinions are hardened by the regular process recommended by the makers of the steel (the Carpenter Steel Co.), with

such modifications as the blacksmith of the shop has found advisable.

The equalizing gear bushings *D* and *D'* are cut out from a bronze bar in the flat turret lathe, being turned and bored complete to size. A stack of them are placed on the Mitts & Merrill keyseater for cutting the internal oil grooves. The radial oil groove is cut on the interesting tool shown in Fig. 13. This device is a modification of the principle used in attachments for slotting screws with a saw held in the speed lathe. The knurled handle shown controls three motions. By screwing it in or out the bushing is tightened or released in the jaws by which it is held. Tripping it up or down drops the bushing away from or brings it up toward the revolving cutter, while springing it to one side brings the bushing out from under the cutter where it can be removed without interference. A wire finger locates the work with relation to the internal groove previously cut.

Assembling

The operation of assembling the parts to make the complete mechanism includes some operations worthy of notice. In Fig. 14 is a case assembled with its two covers and dropped into a cast-iron reaming stand, where it is held from revolving by the projecting pin shown, which enters one of the three

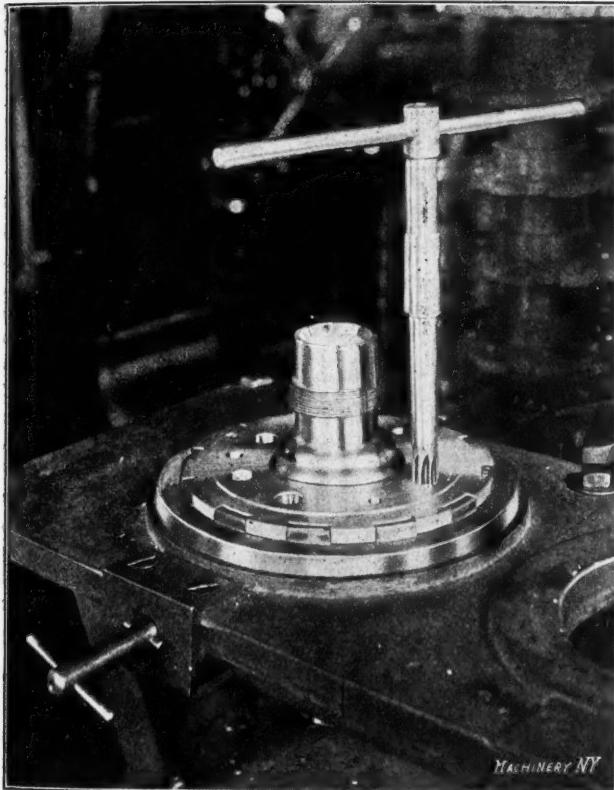


Fig. 14. Line-reaming the Pivot Holes in the Assembled Gear Cases and Covers

holes in its periphery. A line reamer is used, giving assurance that the two bearings in each cover will be true with each other. After this line reaming the covers are marked, numbered and burred so that the same parts will be reassembled together.

Studs *E* are next riveted to the covers, three on one side and three on the other, a hand hammer being used for this purpose. The ends of the rivets are cupped to facilitate this operation. The pinions are assembled on the studs, three on each side. The bushings are pressed into the covers under the arbor press, and burred. The equalizing gears *C* and *C'* are dropped into place and the whole structure is then assembled. A square wrench inserted through the bore into the squared hole in *C*, permits the gears to turn until they are all engaged. Three bolts and nuts *G* and *G'* are now passed through, binding the whole solidly together.

It is of extreme importance in the quiet running of an automobile that the bevel gears run true. For this purpose the bevel gear seat on the outside diameter of the casing is not finish turned until it has been assembled as described. To do this, the mechanism is mounted on the lathe on large centers, bearing on the countersinks in *A* and *A'*. These counter-

sinks, being formed in the same operation with the ball bearing seats and the threads, are true with them. After this turning and facing, a jig fitting on this accurate seat is used for drilling the flange holes through which screws *H* pass to fasten the bevel gear to the casing.

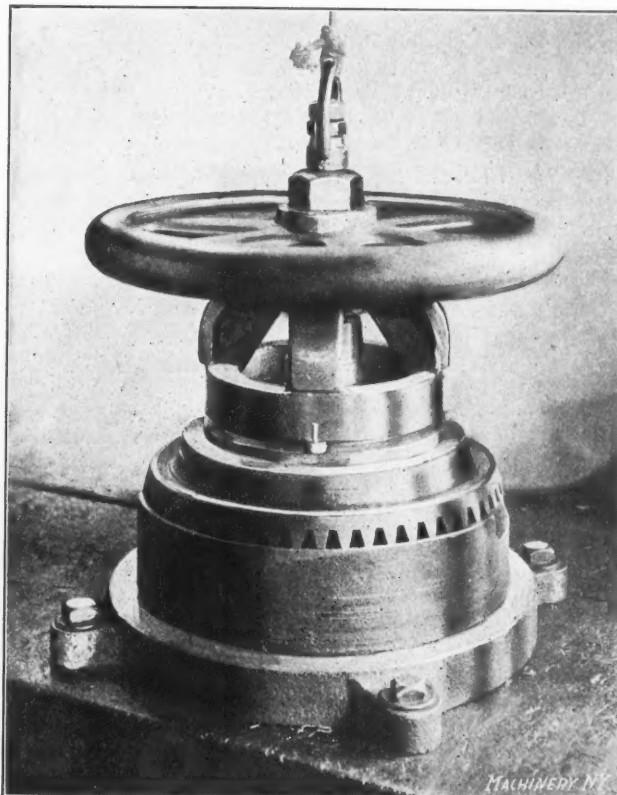


Fig. 15. A Convenient Fixture for Assembling the Gears on the Gear Case

The gear is pressed into place in its seat by a simple contrivance which illustrates the demand for conveniences created by the premium system. On the bench in front of the

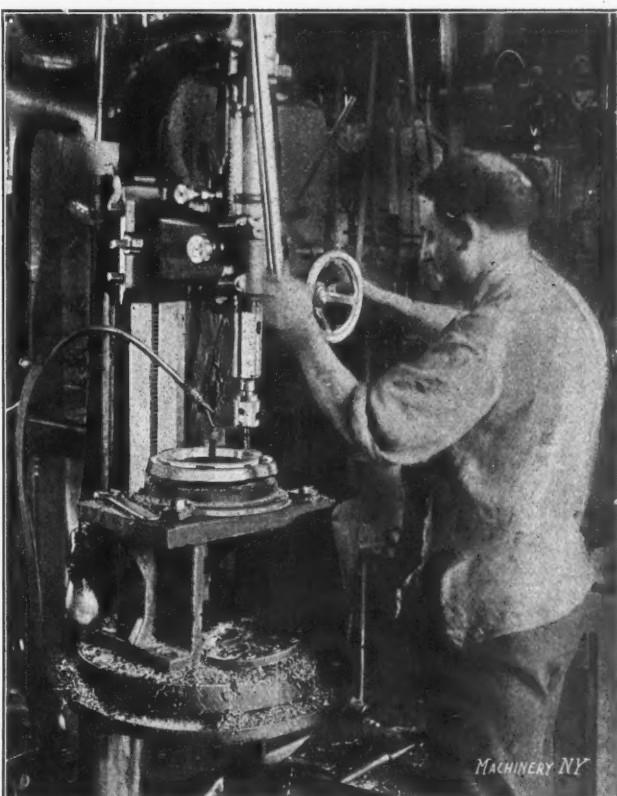


Fig. 16. A Tapping Operation and Operator with a Remarkable Record—75,000 Blind 5-16-Inch Holes in Chrome-nickel Steel without breaking a Tap

workman is a cast-iron seat (Fig. 15) in which the bevel gear is placed face downward. The complete differential mechanism is then placed over the gear in a position to be forced down into it. The workman now reaches up above his head and brings down the hand-wheel, clamping screw and clamp

shown, which is suspended by a counterweight so as to move freely up and down and remain stationary in any position. Entering the screw in the nut in the base of the device and turning the hand-wheel, forces the casing down into the gear and thus completes the assembling. The tap bolts are now put in and are wired through holes drilled through their heads, to prevent them from turning. This completes the making of the equalizing gear.

A Good Tapping Record

While the making of the bevel gear has not been described, it will not do to pass over one of the operations met with. This is the operation of tapping the holes by which the gear is held to the flange. These holes are $\frac{5}{16}$ inch in diameter and $\frac{13}{16}$ inch deep and are blind, being tapped to a bottom and not through. The tapping is done in a Cincinnati drill press (Fig. 16), using an Errington friction chuck. Tapping in chrome-nickel steel by power is, it will be agreed, no "fool of a job." One of the difficulties met with is the tendency of the metal to seize the tap and break it when backing out.

The operator shown broke many taps in becoming familiar with his job, but since he has gotten into the swing of it, he has tapped 75,000 of these blind holes in chrome-nickel steel without breaking a tap. The credit for this record must be divided between the man, the machine, the chuck and the tap, but there is enough to make a respectable showing for all four. It may be remarked that, in accordance with the well-known total depravity of inanimate things, the workman had the misfortune to break a tap a few minutes after the conversation in which I learned his record. His increase of effectiveness was obtained with practically no change in the tools or methods, being due simply to the training of his judgment in the feeling of the tap, and in the use of excellent tools. It might be said that a firm of the highest reputation for accuracy and for skill in manufacturing, had asked ten cents a hole for the job. This operator runs two taps in each of the twelve holes in a gear, twenty-four holes in all, in from 15 to 18 minutes.

Tests on the Finished Casings

Of course, the object that was aimed at in designing these equalizing gears for sale to manufacturers of automobiles, was to give them such strength that some other part of the machine would break first. In order to find out whether or no this result had been obtained a number of tests were made in the laboratory of the engineering school of Brown Uni-

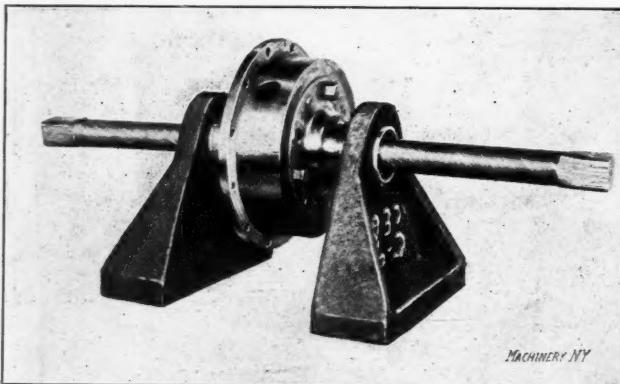


Fig. 17. A Completed Equalizing Gear, Set up for Testing to Destruction by Torsional Stress

versity. In Fig. 17 the casing is shown as mounted in brackets for a torsion test, the power being applied through 1-inch, $3\frac{1}{2}$ per cent nickel steel shafts specially treated. These failed at 20,300 inch-pounds, twisting through 800 degrees before rupture. Samples of broken shafts are shown in Fig. 18, and give some idea, in combination with the figures just given, of the excellence of the material used in these shafts. No damage of any kind was found inside the gear casing, the mechanism being unbroken and running as easily and smoothly as before.

The Providence Engineering Works. feels perfectly confident in offering these equalizing gears to automobile manufacturers, after its experience with them in the laboratory, and their trial in the road conditions met with by the thousands which have been placed on the market.

EXPERIENCES OF A YOUNG TOOL-MAKER

T. COVEY

After Jim had completed his end mills ready for the hardening operation (as described in the August number), he turned them in and was given stock for some spiral surfacing mills, with instructions to make them like a sample given him, and to ream the holes 0.005 inch small so as to leave stock to grind out after the mills were hardened. He proceeded to chuck the pieces in a lathe and face one end and bore the holes. When a $1\frac{1}{2}$ -inch hole had been bored about an inch deep in the first piece, Jim began to have trouble. The steel was hard and tough, and the drill, which was somewhat worn, though apparently sharp, would not cut. Instead it would screech and stick until it stopped the lathe. After many efforts in grinding the drill and trying different speeds, he finally

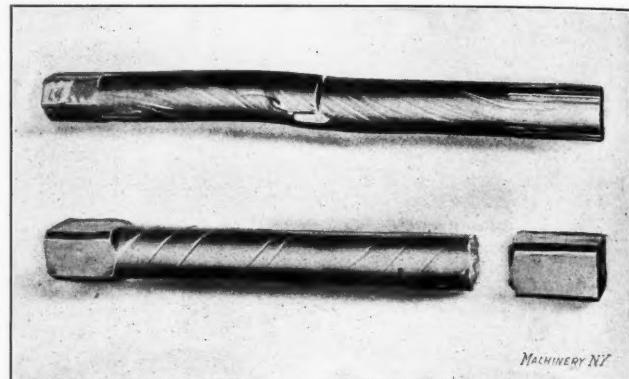


Fig. 18. Condition of Shafts Broken in Tests shown in Fig. 17; the Gears were Uninjured

remarked to a man by the name of Anderson who was working on a machine near him, that that was the worst stuff he had ever tried to drill.

"What is the matter with it?" Anderson asked.

"That's what I would like to know; I can't get a drill to cut it," said Jim.

"Let's see your drill. Is that the best one you could get?"

"Yes. The boy at the window said the rest of that size were out. I guess he thought that was good enough for a kid to use anyway."

"Well, the clearance is gone for an inch at least. Do you know that you can grind a drill so that it will cut a hole larger than itself?"

"I never noticed it in particular."

"Well you can. You just grind one cutting edge longer than the other, so that the point is off center and the drill will cut large."

"I ground it on the drill-grinder and supposed it was all right."

"It probably would be if it was a good drill. Get a boring tool and bore out that hole as far as you have gone with the drill, at least a thirty-second of an inch larger and I will fix this drill so that it will work."

Jim got a tool and bored out the hole. When Anderson came back and handed Jim the drill he said, "There, that will cut large, and in that way it will have clearance on one side. Of course it can't bind much unless both sides rub. I think you will have no trouble in getting it to drill those pieces. I don't say that it is good practice to grind drills that way; a drill properly made and in good condition will clear itself and drill a hole to size, but when a drill is worn out it is no good, and for that reason you could not spoil it. It is a question, however, whether grinding a good drill off center would spoil it or not. Now if you are not accustomed to working tool steel, I can give you a pointer that may save you trouble. When you wish to ream a hole in tool steel, leave more stock for the reamer to cut than you would for cast iron or soft steel; a good thirty-second of an inch will not be too much. If possible use one of the special reamers that we have made for this work as they have more teeth and more clearance or reversed taper. The ordinary commercial reamer, while probably the best for general shop use, will ream too close to size for this job, and it also tends to stick in tool steel."

"I am glad you told me about it," said Jim. "I was of the opinion that the less stock left for the reamer to cut the

better, and I thought one kind of reamer as good as another. This drill is working all right now, and I guess I'll get a hole through *this* piece anyway."

Jim got his first piece bored and reamed without further mishap, but in making a starting hole for the drill in the next piece, he broke his tool by pushing it into the work before he got it central. George happened along about that time and Jim asked him for the loan of his centering tool until he could get his re-forged.

"A centering tool is something that I do not have, and very seldom use," said George. "What do you want to do? Start your drill? I'll show you how to start it without a centering tool. The first thing you want to do is to face the work off square so that the shape of it will not crowd the drill off the center; then place the drill in the chuck so that its cutting edges are in a horizontal position, and start it into the work, so!"

"But it is not running true," said Jim.

"We'll fix that; we will take this lathe tool, which is pretty square across the back end, and put it in the tool-post with the back end forward and clamp it fast, and then bring it up so that it bears against the drill close to the work; then feed the drill in a little, and crowd the tool against it until it looks as if it were central. When the tool is backed away, if the drill still looks central, go ahead; if not, repeat the operation until it is central. You see it saves the time and trouble of grinding and setting a centering tool and for ordinary purposes it is just as good."

As Jim was finishing up his lathe work, Mr. Corbin came along and picking up the sample mill said, "Jim, I want those mills for heavy roughing work and this sample mill has too many teeth; don't cut them like that but cut them about $\frac{5}{8}$ pitch." Just then his attention was called to something else and he gave Jim no further directions. Jim was at a loss to know just what he meant but he did not like to let him know it. As Anderson was working near, he told him that he had been instructed to cut the teeth on his mills $\frac{5}{8}$ pitch, but did not understand just what Mr. Corbin wanted.

"Well," said Anderson, "in this case $\frac{5}{8}$ pitch means $\frac{5}{8}$ of an inch from one tooth to the next."

"But why didn't he tell me how many teeth he wanted? How am I to know how many teeth he wants?"

"He would have to calculate the number before he could tell you, and he left that for you to do."

"I suppose it appears like an easy matter to you but I don't know how to go about it."

"Multiply 3.1416 by the diameter of your blank and divide the result by $\frac{5}{8}$. That will give you the number of teeth. What is the diameter of your mills?"

"About four inches."

"Well, 3.1416×4 is 12.5664, and $12.5664 \div \frac{5}{8}$, or 0.625 is a little over 20. Twenty teeth is what you want."

"Where did you get the 3.1416 from?"

"Why, 3.1416 is the ratio of the circumference to the diameter. That is, the circumference of a circle whose diameter is 1 would be 3.1416 and the circumference of a circle whose diameter is 4 inches would be 4×3.1416 . If you want to demonstrate the truth of this take a piece of cord, pass it around one of your blanks and cut it off so that it goes around once with the ends just touching; take it off and measure it and you will find that it is very nearly $12\frac{1}{2}$ inches long. Then if you wish to carry it further, cut the cord up in pieces $\frac{5}{8}$ of an inch long, count the pieces and you will find 20.

"That is rather interesting, but is a machinist or toolmaker expected to have a knowledge of all such things?"

"I can only answer that in this way. I have noticed that the amount of a man's pay generally depends on his ability, and that toolmakers with a good knowledge of geometry and trigonometry combined with ability to do good accurate work are nearly always paid the best rate of wages."

With that Anderson went to grind a tool and Jim looked around for a milling machine to finish his job in. He found a small one idle and started to set it up when Mr. Corbin saw him and said, "That job of yours is too heavy for that machine; cutting spirals is pretty hard on any machine and you would be apt to strain this little fellow and impair its

accuracy. Use that No. 4 over there—it may be more awkward to handle but it is suitable for the work."

Jim set the machine up for cutting the spiral according to the instructions on the table with the machine, and then as George was working near, he asked him to look it over to see if he had it right. George looked at the gears and referring to the table said they were all right; also the angle was right. Taking hold of the handle that moves the table he tried to turn it but it would not move. "You have not unlocked the index plate so that it can turn," he said. "You should always work the table back and forth once or twice to make sure that everything is free and working properly before starting the machine on a job of this kind."

"What angle cutter would you use for these?" Jim asked.

"Use a regular spiral mill cutter; they have a 12-degree angle on one side and an angle of 40, 48, or 53 degrees on the other. You want a right-hand cutter."

Jim obtained a cutter, a $1\frac{1}{4}$ -inch mandrel, and a dog. On trying the mandrel into one of the blanks, he found, of course, that it was too large, and he went to Mr. Corbin and asked him what to do about it.

"We have hardened and ground mandrels 0.005 inch under size," said Mr. Corbin, "also reamers and expanding arbors of 1-inch, $1\frac{1}{4}$ -inch, and $1\frac{1}{2}$ -inch sizes for work that is to be hardened. A great many shops ream mills and such work to size and depend on the hardening operation to close the holes sufficiently to allow them to be finished by lapping, but we make a great variety of mills that are of irregular shape and unless there is an equal amount of stock around a hole throughout its length it is apt to come back from hardening with one end of the hole larger than the other, making it a difficult and long operation to lap out the hole; and sometimes there is not enough stock to finish. For this reason we leave 0.005 inch stock in the holes of all work that is to be hardened, except the smaller sizes and special cases, and grind them out to size."

Jim took the mandrel back and asked for one 0.005 inch small, which he found fitted all right. When he got his cutter on the arbor and the work in position he began to realize that it was going to be a difficult matter for him to start a cut in the proper place for the simple reason that he did not know how. After thinking about it for awhile he came to the conclusion that it was beyond him. Looking around to see whom he could get to help him out of his difficulty, he saw a man by the name of Joe Waters who was working on a shaper near by and seemed to have lots of time at his disposal as he had just started a cut. Jim went to him and asked him if he would show him how to start a cut properly on one of those blanks.

"I'll try to," said Joe. "A good many fellows put a mill on a mandrel, put it between the centers and set their cutter to that, and I am afraid that there are some men that have laid claim to the title of toolmaker for a good many years that could do it no other way. I sometimes wonder what they would do if they had no sample to go by. You have your cutter on wrong; the side with the 12-degree angle should be next to the machine. Now get a surface gage and set the scriber to the height of the centers of the machine. Generally you will find a line on the footstock center that indicates this height, but where there is none, put the work between the centers and set the surface gage scriber as near to the center as you can guess and scribe a line on both sides of the work, index the work half around and scribe another with the gage at the same height; the center will then be just half way between the first and last lines. The gage is then set as near this point as possible and the operation repeated. When the gage is at the right height, you will be able to make only one line with the scriber on turning the index head half around. Now get some of that acid and rub it on the ends of your blanks so that you can see the lines that you scribe—use a little piece of waste moistened with it."

"Say! that is funny stuff," said Jim; "what is it?"

"It is nothing but water with bluestone, which is the same as sulphate of copper, dissolved in it, with a very small amount of nitric acid added. When it is applied to iron or steel it deposits a thin coat of copper on it. Now move the table of

the machine along until the end of the work next the footstock center is just half under the arbor on which the cutter is mounted and let it stay in this position for the present. How many teeth are you to cut?"

"Twenty," said Jim.

"That means just two turns of the index handle for each tooth, and we will put the index pin in the 21 hole circle. Now scribe a line across the end of your blank next the footstock center, index for one tooth and scribe another, and so on until you have gone clear around the blank. This may seem unnecessary, and it is, so far as starting the cut is concerned, but we need two and the rest serve as a check on the indexing and also would show if the work should at any time slip on the mandrel. When you scribe the last line mark it with a pencil or piece of chalk and turn the index handle 10 turns bringing this line on top. Now the edges of the teeth you are going to cut should be perfectly radial the same as the lines you have just scribed, and the side of the cutter that is to make these edges is to be at an angle of 12 degrees with a vertical line. Let the line that you have marked and turned to the top represent the first one of these edges that you are going to make; now what we want to do is to set this line in position so that the 12-degree side of the cutter is parallel to it, and as the 12-degree side is next to the machine, the line on top must be turned toward the machine 12 degrees; $360 \div 12 = 30$, so we must turn the index head $1/30$ of a turn, and to do this the index handle must be turned $1 \frac{1}{3}$ turn, or one turn and seven holes in the 21 hole circle. There! Now the line you have marked is parallel to the 12-degree side of the cutter, and as your cutter is just half over the end of the blank that has the lines on it you have only to move the saddle in or out until the cutter is over the space between the line you have marked and the one next it at the top. Start the machine and raise the work up under the cutter until the 12-degree side cuts up to the line you marked and the other side comes about $3/64$ inch from the next line. If you wish, you can keep away from both lines until you have taken a cut to see how it looks and satisfy yourself that it is coming all right. You should note the reading on the dial of the handle that operates the knee, and every time you finish a cut drop the work down away from the cutter before you run the table back for another cut, then raise it up again, after running it back, until the dial reads the same as it did before it was disturbed. If you don't lower the work, the backlash in the gears will allow the cutter to cut up the sides of the teeth and make a bad job. You will not need to set up your machine but once for this lot of mills as they are all of the same size and have the same number of teeth. It would be well, though, to index each blank and lay out each tooth with the surface gage, and when you have scribed the lines all around move the index handle $1 \frac{1}{3}$ turn and one of the lines will come in the proper place providing your blank sets with the end next the footstock center just half under the cutter when you are laying out the teeth. Very few toolmakers bother to lay out the teeth before milling, but it is a good idea for a beginner to do so as it gives an opportunity to watch the cutter when it is starting into the blank on each tooth, and if a mistake is made in indexing, or if the blank slips on the mandrel, it will be readily noticed and may be remedied before much, if any, damage is done."

"Thank you for the information," said Jim. "It's a good thing for me that I don't have to cut teeth on the ends of these mills or I would be in trouble again."

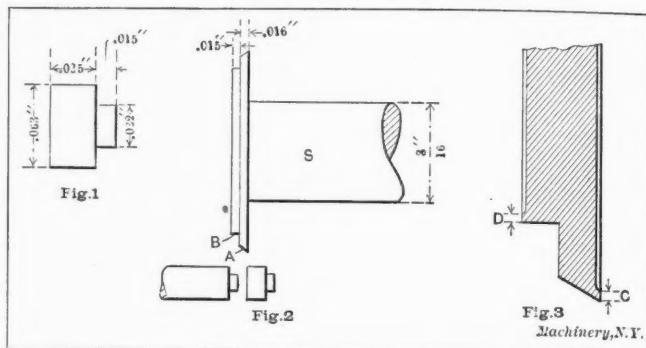
"That is not such a difficult job," replied Joe. "We have cutters in the tool-room that have a 12-degree angle on one side and 65 degrees on the other, which will generally cut the teeth in the ends that have a negative rake, and we usually cut the teeth in the end that would be undercut if the form of the spiral were followed, with a regular 65-degree cutter, not bothering to carry out the form of the spiral on this end, although it may be done quite easily where the index head can be lowered enough from the horizontal to bring the lands equal, by swinging the table around enough to bring the spiral in a position at right angles to the cutter (which would be to the same angle as given for cutting the spiral) and feeding the work in a vertical direction past the cutter. Well my cut is over and I will have to get busy."

MAKING PINS FOR IRIS DIAPHRAGM LEAVES

WALTER GRIBBEN*

The brass pin shown in Fig. 1 is used in the iris diaphragm of a camera, one pin being used in each end of each leaf of the iris. A few of these were wanted by a repair shop, or "camera hospital," to use in repairing diaphragms where a few of the leaves were damaged. On account of the limited number wanted, the job would not admit of very much rigging up. The teat left on the end for riveting in the hole in the leaf should be cupped out a little to facilitate riveting, but permission was asked to omit this cup, as by so doing the pins would be cheapened somewhat, and a solid teat was considered plenty good enough for repair jobs, although it might not do when manufacturing.

The pins were made of brass wire 0.063 inch diameter and were to be 0.035 inch long in the body, while the teat was to be 0.032 inch diameter and 0.015 inch long. No screw machine



Figs. 1, 2 and 3. Small Pin used in the Iris Diaphragm of a Camera, and Disk Tool used for Turning it

was available for this job, so it was done on a bench lathe. The details of the fixtures used are shown in the line cuts, but they are not all drawn to the same scale.

A disk tool, Fig. 2, was made of $\frac{3}{8}$ -inch drill rod. The shank *S* by which it is held, is in one piece with the disk. The part *A* is the cut-off, while the part *B* forms the teat on the next pin to be made. Fig. 3 is an enlarged section through part of the disk tool, showing how the sides were cupped out a few thousandths to make the cutting parts *C* and *D* quite narrow, with the object of making the tool cut more freely and thus throw up less burr on the work.

The halftone engraving, Fig. 4, shows the general arrangement of the improvised apparatus for getting out this job. The iron casting *E* was fastened to the top of the slide rest, and a hole bored in place which eventually held the hard steel bushing that guided the stock. This bushing is held by the set-screw *F*. The rock-shaft *G* is mounted between pointed screws, the one on the left being screwed clear up to the head, while the screw on the right-hand end has a check-nut by which to adjust for a close-running fit without shake. The arm *H*, shown in detail in Fig. 5, is tight on shaft *G*, while arms *K* and *L*, shown in detail in Figs. 6 and 7, are both loose on *G*. The two screws *M* and *N* hold *H* and *K* together, and serve to adjust the disk tool *A* for depth of cut, and thus produce the proper size of the teat on the end of the work, *M* being tapped into *K*, while *N* is tapped into *H*. When *M* and *N* are both tight, *H* and *K* act as one piece. The crank-shaft *O* was made of $\frac{1}{8}$ -inch Bessemer rod, and it carries two eccentrics *P* and *R*, made of $\frac{5}{16}$ -inch Bessemer rod with the hole bored off center. Eccentric *P* works in the open slot in the end of lever *K*, and causes the disk tool *A* to alternately move to and from the stock wire. Eccentric *R* works in the closed slot in the end of lever *L*, and causes the upper slide of the slide-rest to feed along after each cut has been made. The feed is accomplished by means of the pawl *U*, the bell-crank *V*, and the stationary rack ratchet *T*, clamped to the lower slide, the regular feed screw of the top slide being temporarily removed. The bell-crank is pivoted to *E* by a shouldered screw *W*, while another shouldered screw *X*, connects its horizontal arm with the end of lever *L*. Screw *X* had to be a rather loose fit in the end of the bell-crank arm, as *V* and *L* vibrated in different planes, but as the vibration was only

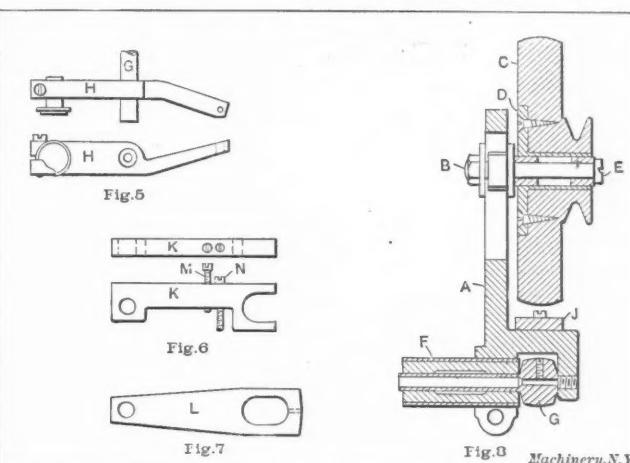
* Address: 314 Halsey St., Brooklyn, N. Y.

over an arc of a few degrees, no trouble from binding was apparent. The rack *T* was cut on one of the edges of a piece of angle brass, the pitch of the teeth being equal to the total length of the finished pin plus the width of the cut-off part of the disk tool, or 0.066 inch altogether. The bell-crank was made of two pieces of sheet brass taken from the scrap box and soft soldered together. This may look like a slovenly way of making a bell-crank, but it was quickly made, and held together long enough to do the job, besides having the advantage that the vertical arm could be made longer or shorter by simply melting the solder. The arm carrying the pawl was adjusted in this way until the pawl moved a little more than one tooth of the rack, but not as much as two teeth. As the movement of the top slide is governed entirely by the pitch of the rack teeth and not by the amount of movement of the pawl, any lost motion in the feed works does not affect the length of the pins, unless it amounts to as much as the distance between two consecutive teeth of the rack. The two eccentrics *P* and *R* were adjusted around on the crank-shaft until the two movements were correctly timed relative to one another; that is, so the feed did not start until after the disk tool had been withdrawn from the work, and also so that the feed was completed before the disk tool started to cut.

As this work is so small in diameter, it was realized that a high speed of rotation was desirable, both to prevent the formation of much of a burr on the edges of the work, and also to reduce to a minimum the little tear left by the cut-off tool. With this object in view, the high-speed drive shown in Fig. 4, which was originally made to drive an internal grinding device, was changed a little to adapt it to present needs. The drive is shown in section in Fig. 8. It consists of the brass casting *A*, the upper end of which is slotted and carries the adjustable stud *B*, on which runs the double wooden pulley *C*, the large part of which is for a flat belt, and the small part for a round belt from the countershaft. This pulley has screwed fast to it a brass flange and hub *D*, into which are forced two hard steel bushings, one in each end, leaving on oil chamber between them. The end of the

ordinary flat rubber band did duty as a belt to connect *C* and *G*, but it had this peculiarity, that considerable crowning on the pulleys seemed to have very little effect on keeping the belt in the middle of the pulley face, so a guiding fork *J* of sheet brass was attached. There seemed to be some structural irregularity in the rubber itself, as there was a tendency for it to crawl to the right when one side of the rubber was next the pulley, but to crawl to the left when the rubber band was turned over.

The mode of operation was to lift the feed pawl and draw the top slide as far to the right as it would go. Then a three-foot length of wire was passed through the lathe spindle and into the hardened guide bushing, in *E* (Fig. 4), after



Figs. 5 to 8. Details of the Attachment shown in Fig. 4

which the small set-screw in pulley *G* (Fig. 8) was tightened and the countershaft started. This gave an estimated speed of 10,000 revolutions per minute to *G*, providing the belt did not slip. Then the crank on the end of *O* was turned by hand, a finished pin dropping off for each turn, until the top slide reached the left-hand end of its travel, when the power was shut off, the slide moved to the right again, the stock wire released and pulled through until it was in the guide bushing once more. After tightening the set-screw and starting the power, a few dozen more pins could be made at the rate of about 60 per minute, when the stopping and returning to the right had to be repeated. The handle *O* could be turned much faster than this, but in that case the momentum of the top slide would be apt to carry it a little too far, and thus make the pins of varying lengths, so it was thought advisable not to exceed the rate mentioned. This fixture left the pins with practically no burr on them, and they were all ready for immediate use.

* * *

At the present time when we are prone to assume that everything undertaken in the mechanical field surpasses in magnitude or difficulty of production anything made in past centuries, it is of interest to recall that the so-called Great Bell of Moscow, made in Russia in 1734, is, according to the *Brass World*, not only the largest bell ever cast, but is also the largest casting of any kind ever made. The making of a casting of the size of this bell would startle the world even to-day. A great Chinese bell weighing 120,000 pounds is another example of ancient casting. As far as is known, these bells were cast from metal melted in close proximity to the mold. One or more furnaces capable of melting the required quantity of metal were so arranged that a trough connected the tap hole with the mold, for tapping the metal directly from the furnace into it. As a matter of fact, this method would, even to-day, be the only practicable one for casting a piece of similar size.

* * *

That the gasoline or alcohol engine is destined to be the farmers' future source of power in preference to the horse, seems to be reasonably sure. It now drives his automobile, shells his corn, grinds his cattle feed, pumps his water, threshes his grain and plows his land. Kansas farmers are using traction gasoline engines to haul their plows, and it is claimed that four men with a traction gasoline engine can do as much plowing as twenty men with horses.

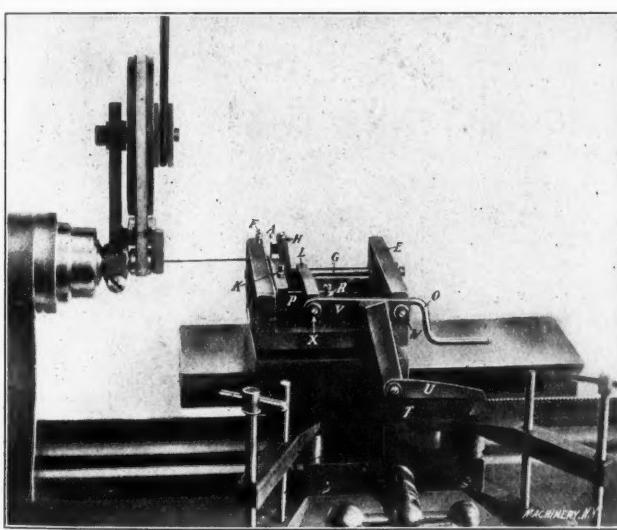


Fig. 4. Bench Lathe Attachment for Turning the Small Pins shown in Fig. 1, at the Rate of Sixty per Minute

stud is tapped, and the large-headed screw *E* is screwed in tight, which prevents the pulley from coming off. The lower part of *A* is bored $\frac{1}{2}$ inch diameter, and has a saw cut and pinching screw to clamp it on the piece of $\frac{1}{2}$ -inch brass tubing *F*, which was tinned with soft solder on the inside and then poured full of babbitt metal. After cooling, it was bored $\frac{3}{16}$ inch clear through and the ends faced. The middle of this hole was bored a trifle larger than the ends, in order to form an oil chamber. The pulley *G* also performed the office of a chuck to hold the brass wire of which the pins were made. It is made of $\frac{1}{2}$ -inch cold-rolled steel, with a long stem on one side $\frac{3}{16}$ inch diameter, this stem being bored $\frac{1}{8}$ inch as far as the pulley, and 0.063 inch the rest of the way. A small headless set-screw in *G* holds the work in place. The part of *F* that projects to the left is grasped in a $\frac{1}{2}$ -inch draw-chuck, and the lathe spindle locked to prevent it from rotating. An

DIE SINKING AND SHOP PRACTICE IN THE ARMSTRONG BROS. PLANT

ETHAN VIALL*

The business of the Armstrong Bros. Tool Co., "The Toolholder People" of Chicago, has grown from the almost insignificant product of a very small shop to the immense output of a factory that is second to none in equipment and which holds its own in size with those far in the front rank. This last statement means something, for as a rule, the business of a shop making small tool specialties does not require a large plant. The growth has not been of the mushroom kind, but has been a strong, steady increase, the result of good sound business management pushing a line of tools that were needed and which were made in a first-class manner. The Armstrong brothers have always been good, steady advertisers, but no amount of advertising could have built up the business that they have to-day, had the tools, the material and the workmanship not been right.

Besides the regular line of lathe and planer tools, the company now makes drop forgings and machine shop specialties

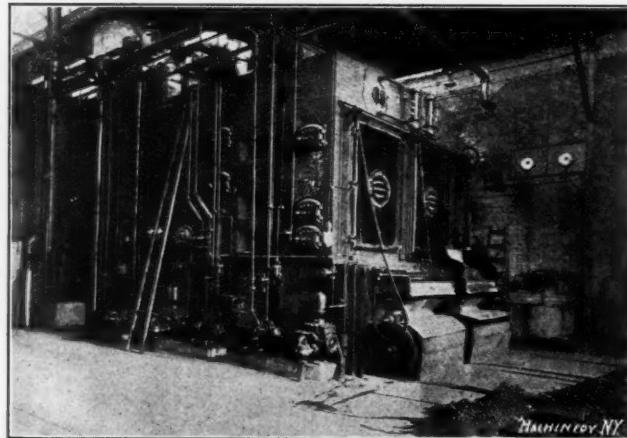


Fig. 1. View of the Boiler Room at the Armstrong Bros. Shop

of several kinds. The factory has its own power and light plant, and the boiler room, a partial view of which is shown in Fig. 1, is a model of neatness and careful planning; it is light, well drained and amply large enough for future expansion. Automatic stokers are used, and the condition in which the place is habitually kept is plainly shown in the engraving, the picture having been obtained one noon when no one knew that it was to be taken, so that no cleaning up for the occasion was possible.

The forge room is partially shown in Fig. 2. The arrangement of alternate steam hammer and trimming press is good. The heating furnaces are also well located, but, unfortunately,

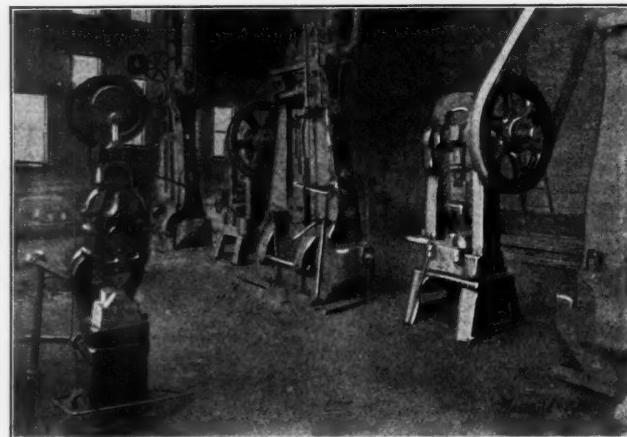


Fig. 2. Arrangement of Steam Hammers and Trimming Presses in the Forge Room

the position from which the picture was taken, would not allow of their being shown. This department, as well as all the others, has been planned with an eye to both present and future needs.

A great many of the articles manufactured, especially the tool-holders, are case-hardened by being packed in large iron

boxes with raw bone and charcoal, and heated in furnaces in the usual way. The method of handling the iron boxes is not, however, as common as it might be. These boxes are made with grooves or corrugations on each side, extending the entire length of the box, and a large iron fork, the prongs of which just fit these grooves, and which is swung from a

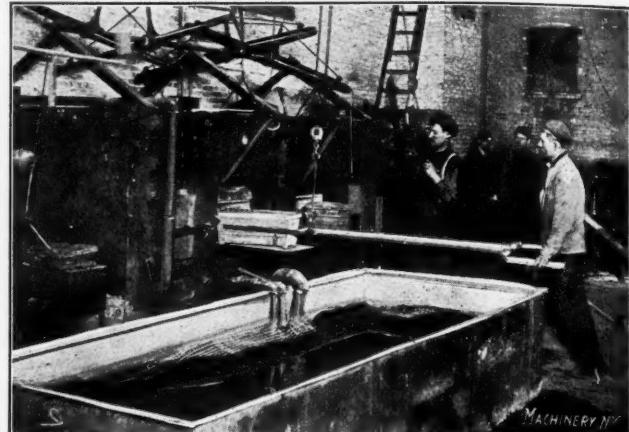


Fig. 3. Case-hardening Furnace and Cooling Tank

traveling tackle, is used to put the boxes into the furnace and to remove them when they are sufficiently heated. When the boxes are removed the contents are dumped into the cooling tank, which is fitted with a screen to keep the parts off the bottom and insure more even and thorough cooling, all of which may be seen by referring to Fig. 3. The screen just referred to, can be easily removed to clean the burnt bone out of the bottom of the tank. When the picture was taken the water was purposely lowered to show the position of the big screen in the tank.

The tool holder set-screws, which are made of tool steel, are heated in a special furnace that heats only the points and

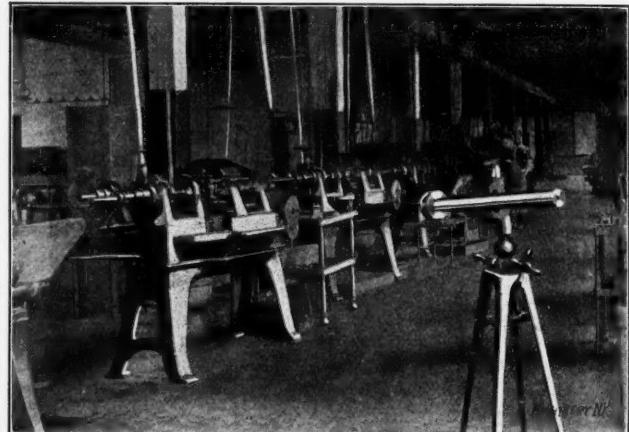


Fig. 4. Battery of Automatic Screw Machines which make the Tool-holder Set-screws

drops them into the hardening bath as fast as the operator can feed them in. The burner of this furnace is the same as that used on a bicycle brazer, and, in fact, the furnace is principally made from the parts of an old brazing stand.

The set-screws just referred to are made by the battery of automatic screw machines shown in Fig. 4. In the foreground is an old universal bicycle vise that is used to hold the big quills while taking out or putting in the spring collets used for feeding the stock. Anyone who has ever run this class of automatics will see the convenience of the old vise, for something of the kind is very frequently needed.

The system used for detailing the dimensions of parts for different sizes of tools of the same class, will be of interest to many, as it saves a great deal of work in the drafting room by making one print do for all sizes. A sample drawing for the six different sizes of spindle and feed sleeves manufactured, is shown in Fig. 5, and for those not already familiar with this method, it will be a revelation in simplicity.

Naturally in a shop depending so much upon drop-forged work, the die making department is one of the most important in the works and is well equipped. This department is in charge of a man of long experience on this class of work,

* Associate Editor of MACHINERY.

though a comparatively young man. One of his remarks hits the drop-forging die problem squarely on the head, and it is that the great difficulty in drop-forging work is not so much in making the die, but in making the metal go into it, meaning, of course, that the breaking down, roughing or bending operations are really the most important and the most difficult to plan out properly. Almost any toolmaker can sink a finishing

be judged from it. For very large forgings such as the C-clamp just mentioned, cast-iron roughing and forming dies are used. The piece is first broken down, bent and rough formed in these dies and then reheated and finished in the tool steel finishing die. Fig. 8 shows a set of wooden patterns for a pair of cast-iron dies weighing 1,600 pounds, or 800 pounds apiece.

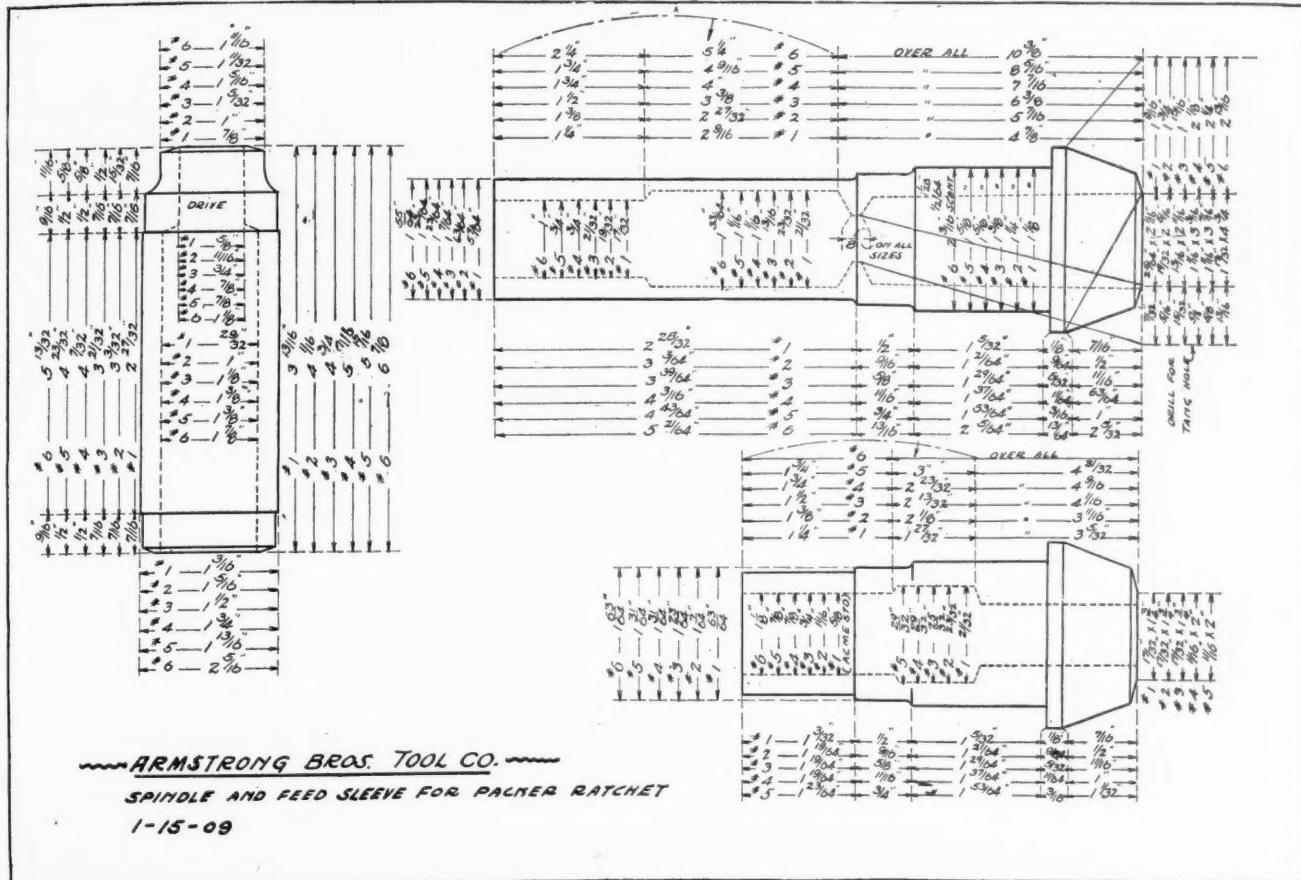


Fig. 5. Drawing giving Dimensions of Six Different Sizes of Spindle and Feed Sleeves

die from a model, but it takes brains and experience to plan and work out the other parts of the die so that it will work satisfactorily without unnecessary waste of time or material. In planning dies or die parts of especially difficult shapes, plaster of Paris models are often used in order to find the best shape or position for the part to lie in; this is especially important in so planning a die as to get that great desideratum of the drop-forging shop—the finishing at one heat.

Many small pieces are forged in "pony dies," which are made of a shoe of tool steel two or three inches thick, which is keyed into a heavy cast-iron or cast-steel block. These pony dies are very economical, as one set of shanks can be made to do duty for a large number of shoes, the shoes all being located by dowel pins and keyed in with a taper key, in the same way that the shanks are keyed into the steam hammer anvil and head.



Fig. 6. View of Drop Forgings as they appear when taken from the Dies

Fig. 6 shows a number of drop-forgings, including toolholders, wrenches, drifts and a C-clamp with the flash still in place. These forgings are just as they came from the steam hammer. A trimmed-off flash is shown on top of the large C-clamp in the middle of the group. Fig. 7 shows a lot of lead proofs of dies for making various sizes of drop-forgings from the smallest to the largest. The big C-clamp shown is 18 inches long and the sizes of the other parts can



Fig. 7. Lead Proofs of Various Parts which are to be drop forged

For working out difficult dies on the profiler, the universal angle-plate or profiling-block, shown in Fig. 9, is used. In this engraving, A is the die and B is the top of the block, which may be swung around in a complete circle, while the part C can be tilted about 45 degrees each way and clamped at any point on the base D. These adjustments give almost any angle required in die sinking, that cannot be obtained in the regular profiler vise.

A special center-bracket used to steady small mill arbors held in the spindle chuck of the profiling machine while working out cylindrical cavities, is shown in Fig. 10. The

The making of dies for the Armstrong boring tool, so that the metal would come out of the die, was quite a difficult problem. This was one of the few cases where getting the

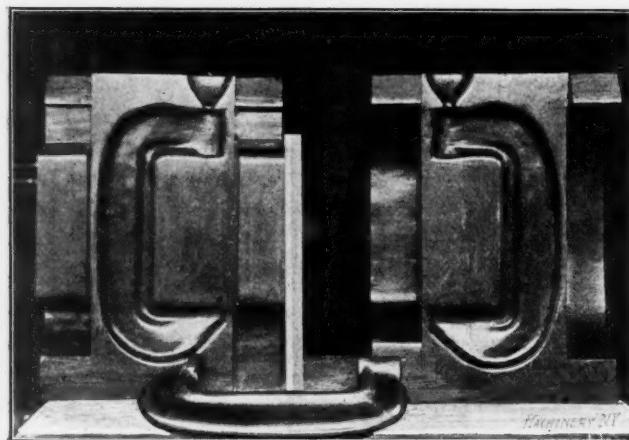


Fig. 8. Wooden Patterns for a Pair of Heavy Cast-iron Dies

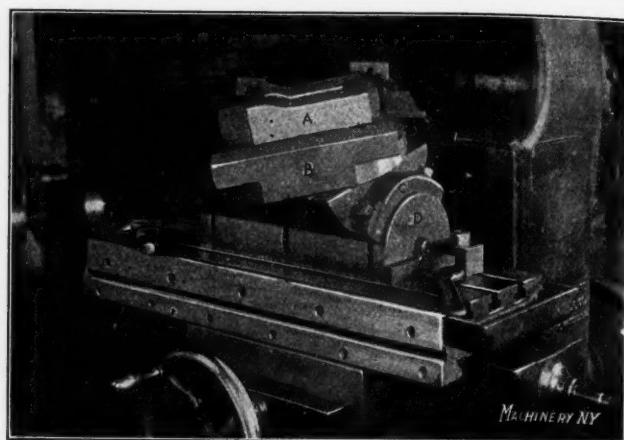


Fig. 9. Universal Angle-plate or Profiling Block used in Die Sinking

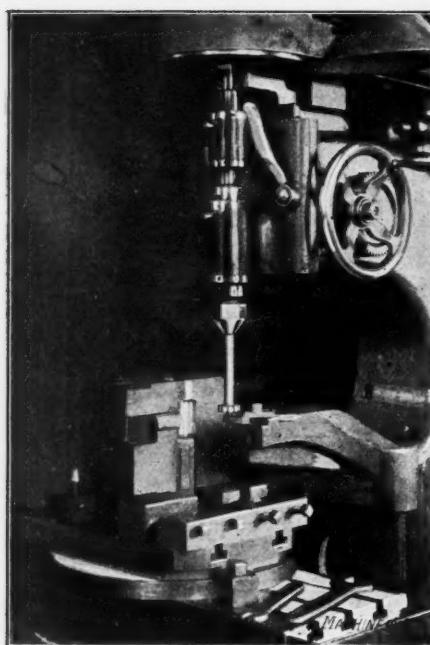


Fig. 10. Special Center Bracket used to Support Small Mill Arbors

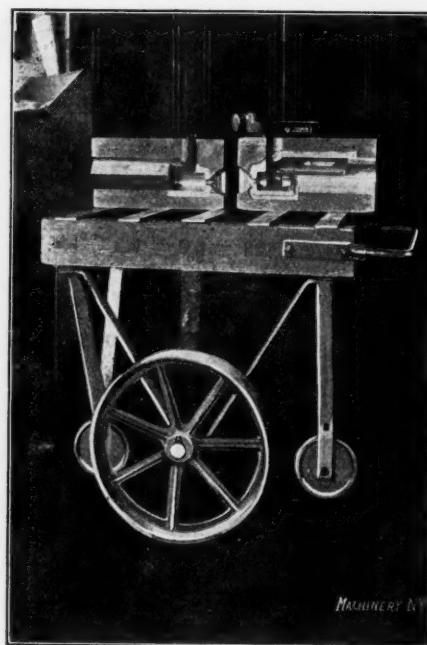


Fig. 11. Dies in which a Boring Tool Shank is forged, and a Convenient Form of Shop Truck

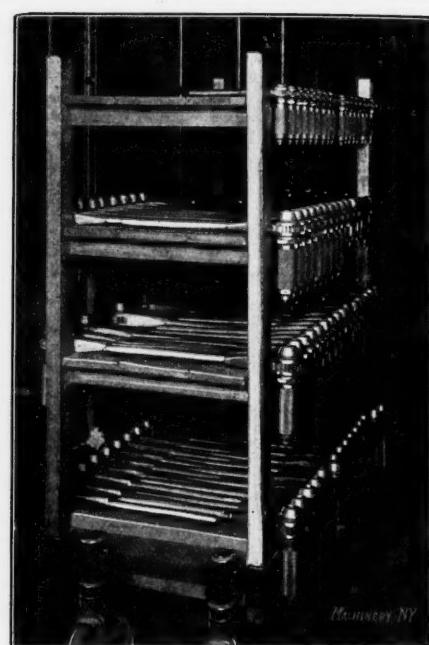


Fig. 12. Shop Truck with Shelves the Same Height as those in the Store-room

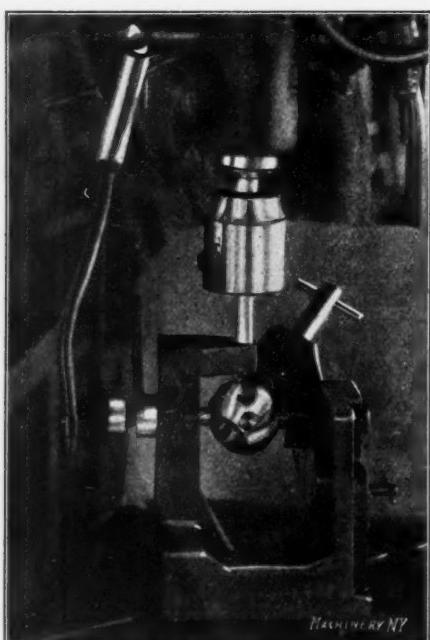


Fig. 13. Indexing Jig for Holding Hubs of Universal Ratchet Drills

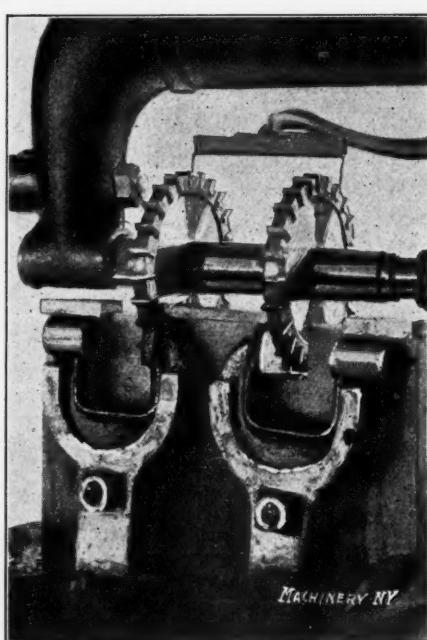


Fig. 14. Fixture which holds Two C-clamps while Faces are being milled

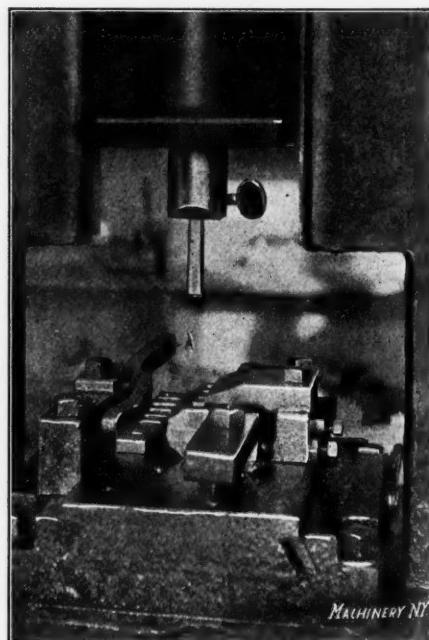


Fig. 15. The Way in which Planer Tool-holders of the Gang Type are broached in a Punch-press

mill used is of the same diameter as the cavity wanted, and it affords a quick, sure way of getting a perfect cavity of the right size.

metal into the die was not the most important thing. It was easy enough to make a die that would forge up the shape required, but owing to the peculiar shape of the boring tool,

the metal would be wedged in too tight to be easily removed. This problem was worked out by using plaster of Paris in the way previously referred to, and the die as it was finally

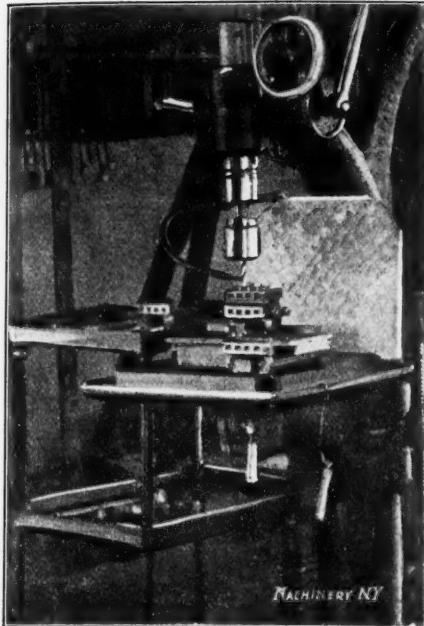


Fig. 16. Drilling Set-screw Holes in the Gang Tool-holders

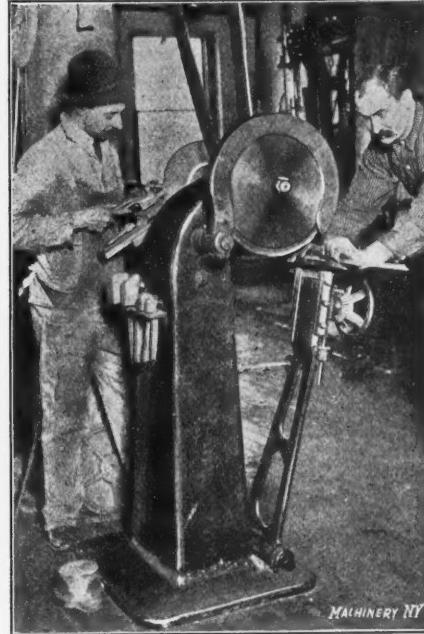


Fig. 17. Cutting High-speed Steel with rapidly revolving Plain Tool Steel Disk

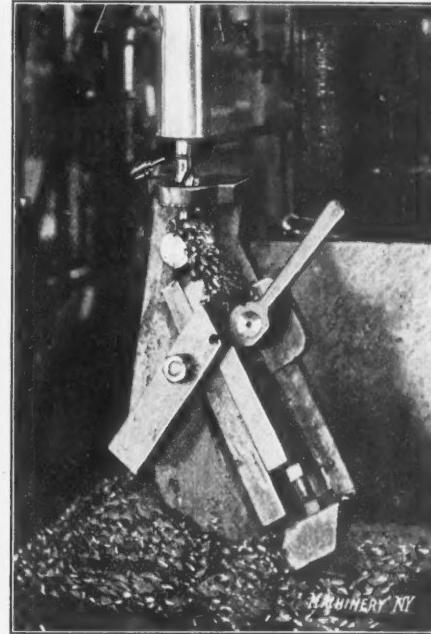


Fig. 18. Simple Form of Chuck for Drilling the Cutter Hole in Off-set Tool-holders

successfully made is shown in Fig. 11. One of the boring tool holders is shown lying on top of the die. The truck shown in this engraving is very useful, as it is just the

high-speed steel into suitable tool-holder lengths with a metal wheel. This wheel is 16 inches in diameter and runs at 2,500 revolutions per minute. It is simply a thin tool steel disk

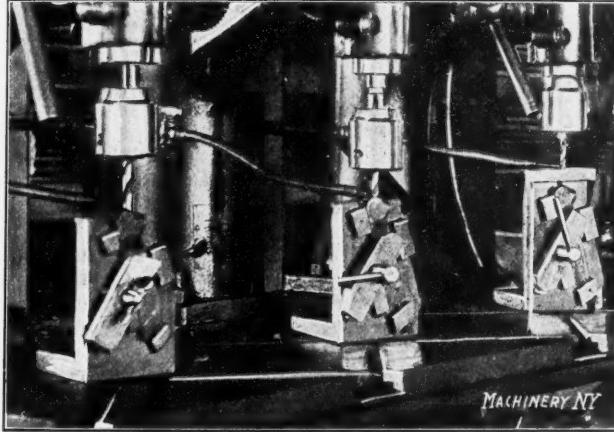


Fig. 19. Drilling the Cutter Holes in the Straight Lathe Tool-holder

height of the work benches and a heavy die can be easily pushed from one to the other. Another very handy truck used to carry finished tools from the assembling benches or shop to the storage shelves, is shown in Fig. 12. This truck is also used to carry tools packed in boxes to the shelves, and as the shelves of the truck are made the same height as the four lower shelves of the store-room, the boxes can be easily slipped into place.

Fig. 13 shows an indexing jig used to hold the hubs of the universal ratchet drills, the construction of which is too plainly shown to need explanation.

In Fig. 14 is shown the milling jig used to hold two C-clamps at once while machining the faces.

Gang planer tool-holders are broached out in a punch press as in Fig. 15. The fixture used to hold the gang tool-holder, is mounted on a slide which is fed under the broach one hole at a time, by lifting the dog-lever *A* and pushing the fixture along until the dog engages the next notch. The view shown was taken from the back of the press. The gang tool-holders are next placed in a very similar fixture, shown in Fig. 16, and the set-screw holes drilled.

Many employers and foremen complain about their men grinding away the tool-holder when sharpening the cutters; consequently a set of special holders has been made for customers, in which to place the steel while grinding. A set of these holders is shown in the rack on the grinder column in

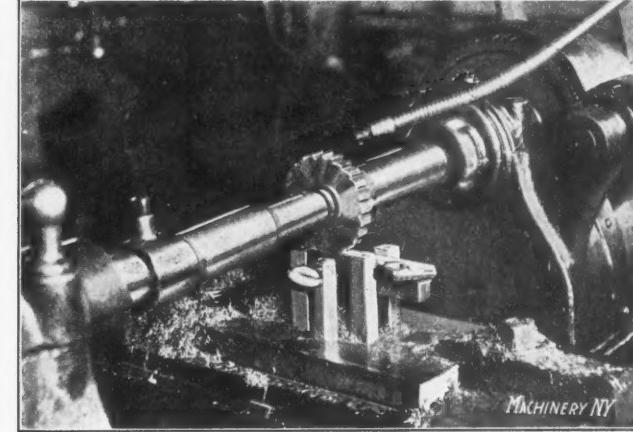


Fig. 20. Milling the Slots for the Blades in Cutting-off Tools

clamped between two big soft-steel washers. The steel bars are not cut off entirely but are just cut into slightly on the four sides and snapped off, the cuts on the sides being as

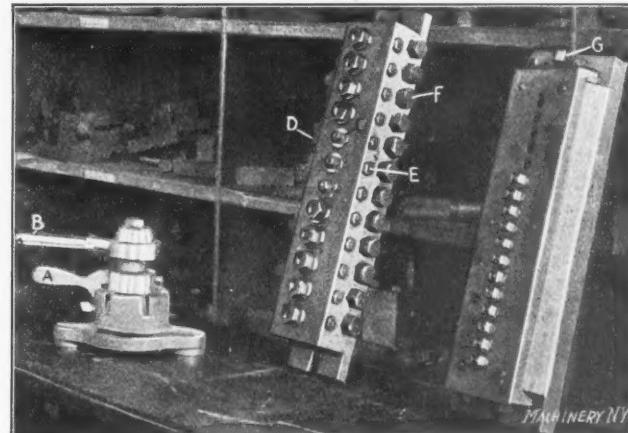


Fig. 21. Interesting Types of Fixtures for Holding Shoulder Nuts and Collar Head-screws, while they are being milled

clean as if made by a milling saw in soft metal. No teeth or anything of the kind are used on the cutting disk and the hard high-speed steel does not quickly wear the softer metal, as a "saw" lasts for a long time.

One of the simplest possible drilling jigs for holding offset tool-holders while drilling the cutter hole, is shown in Fig. 18, while in Fig. 19 is shown a set of three jigs used for the progressive drilling of the long cutter hole in the straight lathe tool-holder. After the cutter holes have been drilled as shown, they are broached out square in special turret broaching machines.

Slots for the blades of cutting-off tools are milled in the holder, as shown in Fig. 20. A close inspection of this jig will show that the tool-holder is pressed from below up against stops. This method makes all slots the same depth regardless of any slight difference in the thicknesses of the forgings. The pushing up of the clamping-block is done by a cap-screw underneath which is turned with an end wrench.

Three very interesting milling fixtures are shown in Fig. 21. The tool at the left is an indexing fixture for milling large hexagon shoulder-nuts, using either one or two mills at a time. The indexing is done by the lever *A*, the nut being held in the chuck which is operated by the lever *B*. The fixture in the center is for holding twelve shoulder-nuts while

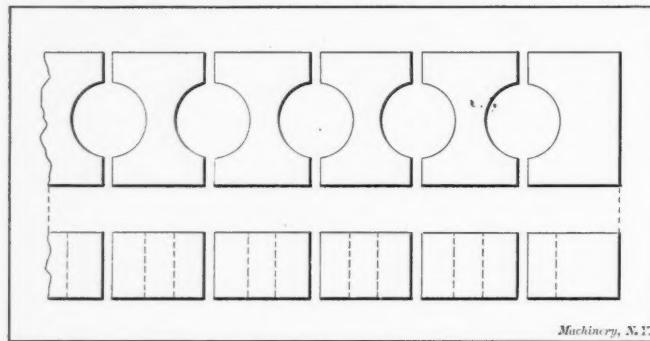


Fig. 22. Detail of the Clamping Blocks used in one of the Fixtures shown in Fig. 21

milling them hexagon, using straddle mills. The blanks are first faced and threaded and then screwed tightly down on the studs *C*, which are kept from turning by tightening the screws *D*. These screws are so arranged as to tighten two studs at a time. The nuts and screws *E* are simply lock nuts and pointed retaining screws, the ends of which fit into a groove turned in the stud shank. At *F* are the spring-actuated indexing stop-pins which are made to engage six notches in the stud shank, so that by simply loosening the lock screws *D* the nuts may be easily indexed with the fingers. Square-headed collar-screws are milled seventeen at a time, in the jig shown to the right. This jig is simple and easily operated. The screws to be milled are held by a series of clamping blocks, shown in detail in Fig. 22, which are set into a channel in the cast iron base of the jig, held in place by an iron top plate and tightened or loosened by the single set-screw *G*. No indexing device is used, but after the first straddle mill cut is taken the set-screw is loosened and the screws are turned a quarter way around by hand and lined up by using a gage with teeth in it like a big comb. The set-screw is again tightened and the final cut taken.

* * *

THE SMALLEST STEEL HAND STAMP

The engraving of the Lord's prayer on one side of a ten-cent piece and other feats of expert engravers even more remarkable have interested and astonished the public from time to time. The letters in these examples are of a microscopic size, and can be read only with the aid of a magnifying glass, but the difficulty of cutting them in copper or silver is small compared to cutting tool steel in relief, as is required for a stamping die. An interesting example of very small steel stamp work is now on exhibition at the New York store of William Dixon, Inc., 39 John St., which is said to be the smallest ever made. The die, which is of the common hand form hardened and tempered, stamps the name WILLIAM HOWARD TAFT in letters one two-hundredth (0.005) inch high, the seventeen letters making a line only 11/64 inch long. The name even when printed by the stamp on white paper with black ink cannot be read, without the aid of a magnifying glass, by any but the very sharpest eyes. The letters are all capitals, clean-cut and well-shaped. A page of MACHINERY on the same scale would be about 1/2 inch x 1 inch.

WATER REQUIRED TO COOL A GAS ENGINE

S. H. SWEET*

The water pump for a gas engine is generally designed to carry off one-half the heat produced by combustion. At times one-quarter would be sufficient but one-half is the amount that should be figured on. If the heat per minute generated by an engine is represented by q , then for a thermal efficiency of 12½ per cent, $q = 339.2 \times 1. H. P.$, and $q \times 0.5 =$ the heat to be carried off by the water.

I. H. P.
The constant 339.2 is obtained from the formula $q = \frac{E}{33,000}$

$\times \frac{778}{I. H. P.} \quad E =$ the thermal efficiency, which for gasoline is taken as 12½ per cent. Hence, $q = \frac{0.125}{0.125} \times \frac{33,000}{778} = 339.2$

$\times I. H. P.$ Other constants may be obtained by substituting the thermal efficiency expected or known. So far as I know the maximum efficiency of gasoline is 19 per cent, and a number of very good engines have shown about 15 per cent efficiency, but for the general run, the safe figure to use is 12½ per cent.

Let

$t - t_1$ = allowable rise in temperature.

t = maximum temperature of water in degrees F. (About 180 degrees should be the maximum temperature allowed.)

t_1 = normal temperature of water in degrees F.

W = the number of pounds of water required per minute, then

$$W = \frac{169.6 \times I. H. P.}{t - t_1}$$

$t - t_1$ = the number of B. T. U. absorbed per pound of water.

As the pump is generally attached to the engine shaft, it

TABLE GIVING PART OF A GALLON PER STROKE FOR VARIOUS SIZES OF SINGLE-ACTING PUMPS

Diam.	Area	Stroke						
		1	1½	2	3	4	5	6
$\frac{1}{2}$	0.196	0.0008	0.001	0.002	0.0025	0.003	0.004	0.005
$\frac{3}{4}$	0.307	0.001	0.002	0.003	0.004	0.005	0.007	0.008
$\frac{5}{8}$	0.442	0.002	0.003	0.004	0.006	0.008	0.010	0.012
$\frac{7}{8}$	0.601	0.0025	0.004	0.005	0.008	0.010	0.013	0.016
1	0.785	0.003	0.005	0.007	0.011	0.014	0.017	0.020
$1\frac{1}{4}$	1.227	0.005	0.007	0.010	0.016	0.021	0.026	0.032
$1\frac{1}{2}$	1.767	0.007	0.011	0.015	0.022	0.030	0.038	0.045
$1\frac{3}{4}$	2.405	0.010	0.015	0.021	0.031	0.041	0.051	0.062
2	3.142	0.014	0.021	0.027	0.041	0.054	0.068	0.082

will have the same number of revolutions as the engine. Let p equal pounds of water required per revolution, then

$$W = \frac{p}{R. P. M.}$$

As one gallon of water weighs 8.33 pounds,

$$\frac{p}{8.33} = \text{number of gallons required per revolution.}$$

Let us take an example and assume that we wish to design a pump for a 20 I. H. P. gas engine which turns at 300 R. P. M.

$$q = 339.2 \times 20 = 6,784 \text{ B. T. U.}$$

$q \times 0.5 = 6,784 \times 0.5 = 3,392 \text{ B. T. U.}$, which is the amount of heat the water is to carry off.

$$t = 180, t_1 = 60, 180 - 60 = 120.$$

$$W = \frac{169.6 \times 20}{120} = 28.267 \text{ pounds.}$$

$$p = \frac{28.267}{300} = 0.0942 \text{ pound per revolution.}$$

$$\frac{0.0942}{8.33} = 0.0113 \text{ gallon per revolution.}$$

By referring to the accompanying table we see that a pump $1\frac{1}{2}$ inch bore by $1\frac{1}{2}$ inch stroke will answer. The number

* Address: 190 Orchard St., Bridgeport, Conn.

of gallons pumped per minute is equal to the number of R. P. M. of a single acting pump multiplied by the number of gallons per revolution as given in the table.

[If the thermal efficiency of a gas engine were 100 per cent, that is if all the heat were converted into work, there would be no rejection of heat into the cylinder walls, and consequently no need for cooling water. Again, if the thermal efficiency were 50 per cent, one-half the heat would be rejected into the walls and exhaust while the other half was converted into work. The formula, therefore, is not strictly correct, as it does not take into consideration the percentage of heat converted into energy and which thus disappears.]

Using the same notation, the formula should properly be:

$$\begin{aligned} q &= \left(\frac{\text{I. H. P.}}{E} \times \frac{33,000}{778} \right) - \left(\frac{33,000 \times \text{I. H. P.}}{778} \right) \\ &= \frac{(33,000 \text{ I.H.P.} \times 778) - (33,000 \text{ I.H.P.} \times 778 E)}{778 E \times 778} \\ &= \frac{25,674,000 - 25,674,000 E}{605,284 E} \end{aligned}$$

If $E = 12\frac{1}{2}$ per cent, then:

$$\begin{aligned} q &= \frac{25,674,000 - 3,209,250}{75,660.5} \\ &= 296.8 \end{aligned}$$

The thermal efficiency of gas engines being rarely more than 20 per cent the error in Mr. Sweet's method is not important and for practical purposes it is to be preferred because of its simplicity.—EDITOR.]

* * *

HOW BILLY CENTERED SHAFTS

H. A. D.

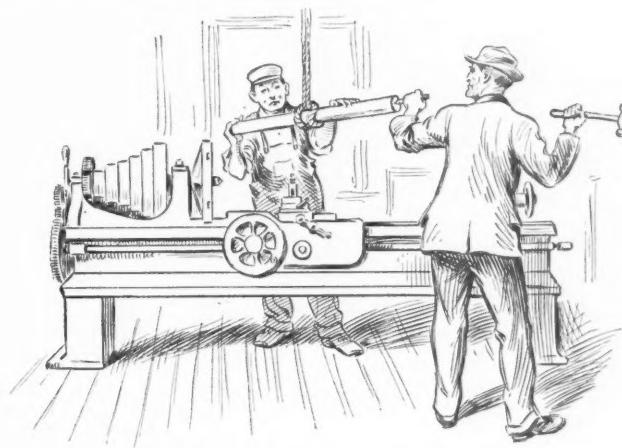
Mr. William Collis, affectionately known amongst the boys as "Billy," was the foreman of the turning shop some twenty years or so ago. He was a working foreman too—not one of the kind who was afraid to dirty his hands—and to fill in his time between Monday morning and Saturday noon, when he was not giving out work or looking after his men he ran the shafting lathe—or rather the shafting lathe ran itself even when he was looking after the men, or when he was dozing on the top of his tool-chest, for in that shop there was no tool-room and each man kept his own special fancies in the way of tools, etc., under lock and key. High-speed steel was in the dim and distant future, and a cut over a shaft lasted a long time.

Now Billy's method of centering was as primitive as could be, the usual tools consisting of a center punch and hammer only. A square center was used sometimes, but this gave trouble in changing centers, putting something in the tool-post to press the shaft, and other little worries which could be avoided; therefore, by placing the center punch where he guessed the center of the shaft should be, and hitting it several good smart blows the thing was done—except, of course, when he had miscalculated as to the exact position of the center. It was then necessary to try the shaft in the lathe, and if too much eccentricity was found he would mark the "high side" with chalk, remove the shaft and "draw" the center by means of the punch, the shaft being swung in and out of the lathe by means of pulley blocks.

His assistant on the operation was generally one of the newer lads knocking around, and for the particular shaft in the story the services of Harry had been secured. Now Harry's sense of humor (?) was strongly developed, and he hated this particular job just as much as he was afraid of Billy, but his love of a joke overcame his fears one day, and here is the story:

Billy had made a particularly bad guess as to the position of the center of the shaft and had followed his usual practice up to the point of swinging the shaft out of the lathe, when he was called away to attend to some other duty. As Harry lolled around waiting for the work to proceed again, the little chalk mark persistently stared him in the face in such a manner that finally an idea struck him, that it would be funny if he rubbed it out and placed another on the *opposite side*. Of course, as in most things of importance, the main

thing was to have the idea, the rest was easy and was soon accomplished. It was too good a joke to be enjoyed alone and several others soon knew what had been done, amongst them being one of Billy's own particular cronies. Billy returned soon afterwards, and resuming operations, drew the center towards the mark. His surprise was very pronounced when he saw the result of his latest efforts and the remarks he made about shafts in general and this one in particular are unprintable, but he fairly lost his temper when he caught sight of someone smiling, apparently at him.



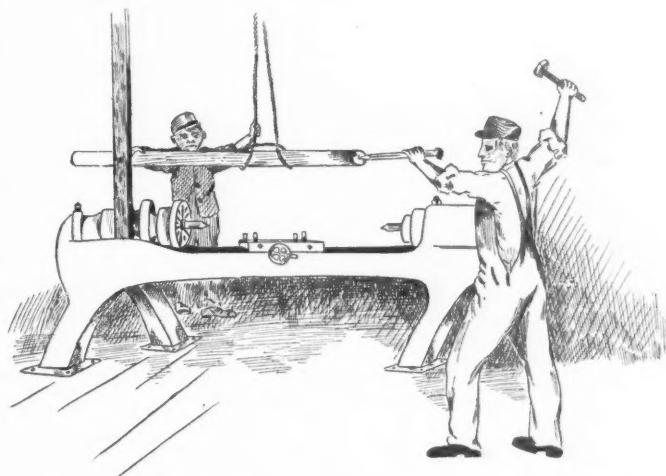
"Now Billy's method of centering shafts was primitive"

Poor Harry wanted to laugh, too, but dared not, so offered what consolation he thought would meet the case, suggesting that Billy had perhaps made a mistake, and should have drawn the center *away* from the mark, but Billy said he might do that when he started his second apprenticeship and knew no better. From his manner towards his assistant the next day it was clear he had learned over night what had occurred, but he was not vindictive, and afterward enjoyed the joke as much as anyone.

* * *

HOW BILLY DIDN'T CENTER SHAFTS

This startling sketch illustrates an amateur artist's weird conception of a shafting lathe and a machinist's way of handling centering tools. He was asked to make a drawing for "How Billy Centered Shafts," and the result exceeded our wildest expectations. We are impressed particularly with the lathe legs. How well they don't harmonize with modern



"Our regret is that we don't know the tool-smith who forged that center-punch and the concern that made the hammer"

ideas of machine design; they appear to us to belong to the bulldog type of architecture! Note the "patent" head-stock and the "unpatent" foot-stock, and the doleful expression of the cub, who can't for his life see how to swing an eight-foot shaft between five-foot centers. The carriage is a gem—but why proceed further? The makers are unknown and we don't care. Our regret is that we don't know the toolsmith who forged that center-punch and the concern that made the hammer.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, \$1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—\$2.00 a year, coated paper \$2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, \$3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, \$2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

CHINESE METHODS IN DESIGN

One of the most delightful of Charles Lamb's "Essays of Elia," deals with the alleged discovery of roast pig by the Chinese. As the story goes, a Chinaman's house was burned up and his pig lost in the flames. While poking around in the ruins the Chinaman came upon the body of the unfortunate beast, and in the handling found it necessary to cool his fingers, which he did by putting them in his mouth, when he tasted for the first time in the history of mankind the sweet and delicate flavor of roast pig. The narrative goes on to state that for some time thereafter Chinamen's houses were burned down regularly and frequently, and roasted pigs were always found in the ruins, until an inspired genius discovered a shorter and less expensive method of producing the same result.

It sometimes seems as though there are very few machine designers who have gotten out of what may be called the "house burning stage" in machine design. Why is it that nine times out of ten the first design of a new machine is too light, the second design a little heavier, the next heavier still; and only in the course of years is the tool designed so as to be strong enough for its work? Instead of wasting time and money all around in repeated strengthening, why not make the machine strong enough in the first place—or even too strong? It would be a welcome change to see a machine pared down a little in weight in successive developments, instead of having it corrected repeatedly in the opposite direction.

* * *

ELECTRIC DRIVE IN THE MACHINE SHOP

When electric drive was first being introduced into machine shops and factory equipment, claims were made for the power saved by elimination of line-shaft and belt losses, and the more important but not obvious economies were not pointed out, either because of ignorance or lack of appreciation. In the machine shop the greatest advantage of electric drive doubtless lies in the increase of product made possible by constantly adjusting the speed of the work to the full capacity of the cutter and thus working the machine always at its maximum

rating, pre-supposing that variable speed motors are used to drive the machines. In a paper on the economy of electric drive in machine shops, to be presented before the A. S. M. E. in December, Mr. De Leeuw lays stress on this element of advantage, it being of much greater importance than the mere saving of power. In fact we may conclude that if it were simply a matter of saving power it is doubtful if it would pay in many cases to make the change from line-shaft drive to motor drive.

To illustrate, the conditions in a shop are quoted where an average of nine tons of metal is machined daily. The metal is, for the greater part, cast iron with a small percentage of steel, bronze and other metals. The chips removed amount to about 2,700 pounds of metal in a nine-hour day, making 300 pounds per hour or five pounds per minute. The power required is about 225 H.P. which, with a production of 5 pounds of chips per minute means that 45 H.P. per minute for each pound of chips removed is consumed. The power costs about \$40 per H.P. per year or \$9,000 per year including the steam for heating the building. Now, if one-half the amount spent for power could be saved by another mode of drive, the total possible gain would be only \$4,500 per year. The shop employs about 500 men, and the gain per man would be \$9 per year. The yearly product per man is about \$2,000 from which it becomes evident that the small gain of 5 per cent in productive capacity would be much greater than the saving in power, and this is a large consideration in the economy of electric drive in the machine shop.

The importance of increasing the product by the substitution of electric drive for line-shafts and belts is greatest in the matter of capital investment when a plant is working practically to its limit, and any increase of capacity in the direction of new building and new machinery means perhaps a prohibitive cost, to say nothing of the delay in getting the equipment into shape. The substitution of electric drive to increase the capacity may make an increase in the number of machines unnecessary, and thus save making a large investment, much greater than the cost of the change. There are other advantages than those of electric drive that may be enumerated, but the increase in efficiency of machine and man made possible by the variable speed motor is the chief consideration for the machine shop manager.

* * *

STRESSES IN CURVED MACHINE MEMBERS

The A. S. M. E. paper on stresses in curved machine members, abstracted in another part of this number, engineering edition, is a valuable contribution to the society's proceedings, being one that can be studied with profit by designers of hooks, punch and shear frames, C-frame riveters and other similar structures in which the loads induce combined tensile

$\frac{W}{I}$ and bending stress. The familiar formula $f_c = \frac{W}{I}$ found in text-books on machine design is based on the assumption that curved machine members under load act as do beams originally straight, but this supposition has been known for some time to be erroneous, the calculated factor of safety being much more than that known to actually exist. The results of tests on hooks of cast steel and wrought iron at Columbia University show conclusively that the old formula is very seriously at fault, the actual load at the elastic limit being, roughly, one-half, or less, of the calculated load.

So serious a discrepancy between the results of calculations and actual tests, and on the wrong side at that, cannot be tolerated. Future treatment of the subject in works on machine design must take into account the newer theory from which Andrews and Pearson have deduced a formula that appears to agree well with the results of tests. In fact, there is a surprisingly close agreement of the test loads and the calculated loads in the Columbia experiments when figured by this formula. Unfortunately it is not readily handled by a designer unfamiliar with higher analysis, but by the use of constants that have been derived for the common hook section, the use of the resulting modified expression is made comparatively easy.

It is cases like this that have given cause for the not uncommon belief that theory and practice do not agree, and it is not strange that the hard-headed practical man has some contempt for the purely theoretical designer, when machine members fail with no apparent reason in theory. But, theory and practice will agree when the theory takes into consideration all the factors affecting the problem and the mathematical formulas are correctly deduced. Effort to fit a fact to an untenable theory must necessarily fail, and when it fails, as in this case, in producing results that are tolerable, we must change the theory to fit the fact.

* * *

TURBINE PUMP MOTOR DRIVE

The turbine pump has come to be recognized as a practical pumping machine peculiarly well suited to certain conditions, the same as the steam turbine prime mover. It has been used for pumping against very high heads with success, but notwithstanding its essential simplicity, some peculiar problems have been met in its design and construction that have baffled the designers. One of these problems concerns the matter of drive. When a turbine pump is driven by an electric motor, the motor conditions become very bad if the head fluctuates. There is great danger of over-loading the motor with a low head, strange as it may seem at first thought. The natural inference is that with a low head the load would become less than with a high head, but the contrary is the case. A turbine pump designed to deliver a certain quantity of water against a head, say, of 100 feet will operate smoothly when driven by an electric motor so long as the water approximates the given head, but should the head fall to 75 or 50 feet, the chances are that the motor would be over-loaded. A larger quantity of water than normal is pumped at lower efficiency, the work done increasing rapidly with decrease of head.

The reason for this action is that the turbine pump operates under conditions analogous to those affecting the electric generator. A generator carries its normal load so long as the resistance in its circuit is that for which it is designed. But, should a short circuit or reduction of resistance through other means occur, the generator at once becomes over-loaded, and will break down or burn out if continued in operation. In the case of a turbine pump, the head corresponds to the ohmic resistance and the quantity of water pumped to the amperes of current. When the head under which a motor-driven turbine pump is working decreases, the pressure or resistance is decreased and the quantity of water handled is increased, the consequence being that the pump is over-loaded while working at a low efficiency, the same as the generator. The over-load must be carried by the motor and unless the motor has good over-load capacity it will not stand up under the service. However, the characteristics of the best turbine pumps have been improved so that considerable fluctuation of head will not greatly increase the load or decrease the pump efficiency.

* * *

GASOLINE AND ALCOHOL MOTORS COMPARED

The United States Geological Survey, has just issued a bulletin on "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines," by Robert M. Strong. The tests, which were under the technical direction of R. H. Fernald, engineer in charge of the producer-gas section of the technologic branch, were conducted at the fuel-testing plant in St. Louis, Mo., and at Norfolk, Va. The tests dealt primarily with gasoline, forming part of the investigation of mineral fuels provided for by acts of Congress. To determine the relative economy and efficiency of gasoline it was compared with denatured alcohol. When the series of tests was started, it was found that it took from one and one-half to two times as much alcohol as gasoline to produce a given power. With special alcohol engines, entirely suited to the use of alcohol, the latter fuel has been made to do as much work, gallon for gallon, as the gasoline.

By using alcohol in an alcohol engine with a high degree of compression (about 180 pounds per square inch above atmospheric pressure—much higher than can be used for gasoline on account of pre-ignition from the high temperatures pro-

duced by compression) the fuel consumption rate in gallons per horse-power per hour can be reduced to practically the same as the rate of consumption of gasoline for a gasoline engine of the same size and speed. The indications are that this possible 1-to-1 fuel consumption, ratio by volume, for gasoline and alcohol engines, will hold true for any size or speed, if the cylinder dimensions and revolutions per minute of the two engines are the same.

The low heating value of completely denatured alcohol will average 10,500 British thermal units per pound, or 71,900 British thermal units per gallon. The low heating value of 0.71 to 0.73 specific gravity gasoline will average 19,200 British thermal units per pound, or 115,800 British thermal units per gallon. Thus the low heating value of a pound of alcohol is approximately six-tenths of the low heating value of a pound of gasoline. A pound of gasoline requires about twice the weight of air for complete combustion as a pound of alcohol.

A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horse-power about ten per cent greater than when using gasoline. When the fuels for which they are designed are used to an equal advantage, the maximum available horse-power of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds, but of the same size in respect to cylinder diameter, stroke and speed.

Alcohol diluted with water in any proportion, from denatured alcohol which contains about 10 per cent of water, to mixtures containing about as much water as denatured alcohol, can be used in gasoline and alcohol engines if they are properly equipped and adjusted.

When used in an engine having a constant degree of compression, the amount of pure alcohol required for any given load increases and the maximum available horse-power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied. The rate of increase and decrease respectively is such, however, that the use of 80 per cent alcohol instead of 90 per cent, or denatured alcohol, has but little effect upon the performance of the engine; so that if 80 per cent alcohol can be had for 15 per cent less cost than 90 per cent alcohol and could be sold without tax when denatured, it would be more economical to use the 80 per cent alcohol.

The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels for marine and factory engines and engines to be placed in the basements of office buildings, in coast defense fortifications, or in like places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply, or where the forming of explosive or inflammable mixtures of the fuel vapors and air in the immediate vicinity would be hazardous. It is indicated by statistics and is also the general consensus of opinion of those experienced in handling gasoline, kerosene, and alcohol that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene, but as yet the relative fire risk has not been definitely established. Considerable work has been done on this phase of the investigation and a series of tests that will be of assistance in determining the relative hazard involved in the use of these fuels is in progress at the testing station of the Survey in Pittsburg.

In regard to general cleanliness, such as absence of smoke and disagreeable odors, alcohol has many advantages over gasoline or kerosene as a fuel. The exhaust from an alcohol engine is never clouded with a black or grayish smoke, as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete, and, it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied, as is so often the case with a gasoline engine. The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

Very few alcohol engines are being used in the United States at the present time, and but little has been done toward mak-

ing them as adaptable as gasoline engines to the requirements of the various classes of service. Engines for stationary, marine, and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have, however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is, in general, relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available, and it seems reasonable to expect that the price of denatured alcohol will eventually become as low or lower than the price of gasoline, especially if the price of gasoline advances. It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

When used as a fuel, denatured alcohol is not always so classed as to be exempt from restrictions placed on the use of gasoline by the rules of insurance and transportation companies or city ordinances. The restrictions that are placed on the use of denatured alcohol are, however, never greater than those placed on the use of gasoline. In some places, they are such that the use of an alcohol engine is permitted where the use of a gasoline engine is prohibited. For instance, alcohol motor trucks and automobiles are admitted to many steamer piers that are not open to gasoline machines.

When the restrictions placed upon the use of denatured alcohol are less than those placed on the use of gasoline or where safety and cleanliness are important requisites, the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in fuel expense, especially if the cost of a fuel is but a small portion of the total expense involved, as is often the case. Denatured alcohol will, however, probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to ability to service required and quantity of fuel consumed per brake horse-power, which has been demonstrated to be possible, becomes more generally realized.

A further general development in the design and construction of engines that use kerosene, or cheaper distillates, and the crude petroleums may be reasonably expected and may delay the extensive use of denatured alcohol for some time to come, but as yet comparatively few data pertaining to this phase of the general investigation are available.

* * *

AUTOMOBILE SPRINGS

The development of the automobile has proved that the ordinary carriage spring is inadequate to meet the severe requirements of automobile service. Manufacturers have experimented with many grades of foreign and domestic steels including chrome-nickel, tungsten, vanadium and other special alloys with results more or less satisfactory depending largely on the heat treatment. The experience of some makers, members of the A. L. A. M., appears to indicate that silico-manganese springs endure longer than high carbon steel, but whatever steel is used, it must be made to certain specified analyses and heat treated in an approved manner to yield satisfaction. It is necessary to have the furnaces under pyrometer control, and so closely regulated that there is but very slight variation in temperature. The most commonly used heat treatments are annealing, hardening, tempering, hardening and annealing, double annealing, and double hardening. A long flat spring is preferable to a spring with considerable arch as the fiber stress is lower for the same load and deflection. The deflection should not be more than one-fourth inch per hundred pounds. The reason leaf springs are preferable to coil springs is the greater dampening effect of the leaf springs, because of the friction between the component parts of the spring. A leaf spring does not return to its normal position so quickly and forcibly as a coil spring of the same capacity, hence its easier effect upon the car and its occupants.

THE DESIGN OF CURVED MACHINE MEMBERS UNDER ECCENTRIC LOAD*

Machine members, such as frames for punches, shears and riveters, hooks and the like, when subjected to load, are generally supposed to behave like beams originally straight and subjected to the same conditions. The usual analysis applied to such beams in determining the proportions required to withstand safely a given stress assumes that the maximum tensile stress equals the load considered as uniformly distributed over the section plus the stress due to the eccentricity of the load. Symbolically expressed

$$f_t = \frac{W}{A} + \frac{Wc}{I}$$

f_t = maximum intensity of tensile stress,
 W = load on beam,
 A = area of section,

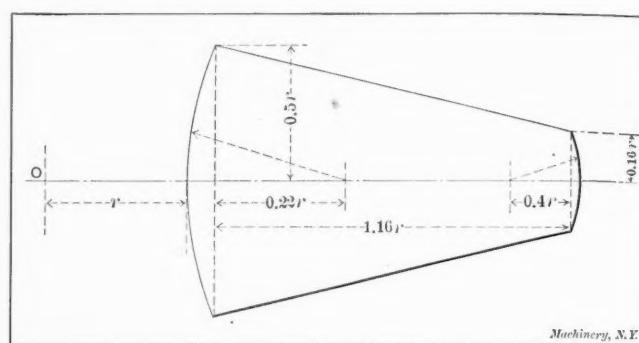


Fig. 1. Section of Crane Hook

l = eccentricity of loading,
 e = distance from gravity axis of section to point under stress f_t ,
 I = moment of inertia.

This analysis is unfortunately prevalent in textbooks on the design of machine elements and strength of materials, and has been accepted generally because of long standing. However, it does not agree with the results of experiment on members of this kind; in fact such experimental results are so different from results calculated by this formula that no confidence whatever can be placed in it, and safe proportions can be obtained only by the use of a large factor of safety.

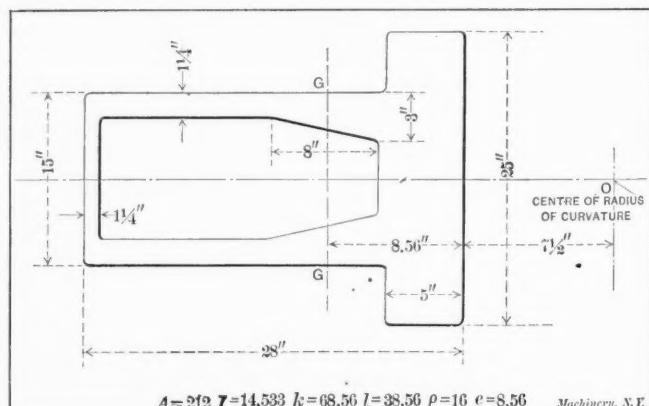


Fig. 2. Section of Punch and Riveter Frame

The results of a series of experiments which are remarkable in their disagreement with the results obtained by the formula are given in the accompanying table. The crane hook was taken as an example of a beam of this sort and experiments were conducted on ten hooks ranging from two to thirty tons rated capacity.

It is very evident that the assumptions on which the conventional formula is based are not correct, and that machine members designed on this basis have a much smaller factor of safety than is generally supposed. While this has been known in some quarters and attempts have been made to bring about an adjustment, no theory which has been developed seems to fit the case better than that evolved by E. S. Andrews and

* Abstract of paper by Prof. Walter Rautenstrauch, read before the November, 1909, meeting of the American Society of Mechanical Engineers.

Prof. Karl Pearson of London University. Their investigation gives the following expression for the tensile stress at the most strained point in the principal section of beam:

$$f_t = \frac{W}{A} \left\{ \frac{l}{\rho \gamma_2} \left(\frac{1}{\left(1 - \frac{e}{\rho} \right)^{\frac{1}{2}}} - \gamma_1 \right) + 1 \right\}$$

f_t = tensile stress at most strained point of section, pounds per square inch,

W = load on hook, pounds,

A = area of section, square inches,

l = distance from load line to gravity axis of section,

ρ = radius of curvature of belly of hook at gravity axis,

e = distance from gravity axis to point of maximum tensile stress,

γ_1 and γ_2 are functions the values of which are determined for each section by means of rather complicated higher analysis; approximate values are given in the following.

This formula was applied to each of the hooks tested, with the results recorded in the third line of the accompanying table. An inspection of this table will show how nearly the analysis of Mr. Andrews and Professor Pearson fits the case.

In its present form it is a rather unwieldy instrument in the hands of a designer, but it may be made

more applicable to design By test..... 56,000
than might be thought at By standard formula..... 115,000
first. The functions γ_1 and γ_2 are constants for

all sections of similar form, that is, for all sections the proportions of which may be expressed as a function of some unit of dimension, for example, the radius of curvature. Under the same circumstances the entire expression within the brackets is a constant. The equation for a series of sizes and sections may therefore be written $f_t = \frac{W}{A} - K$, or $A = \frac{W}{f_t} - K$. The area is a function of the unit squared $A = C' r^2$, and therefore we may write $A = C' r^2$, or

$$r = \sqrt{\frac{K}{C'} \times \frac{W}{f_t}} = C \sqrt{\frac{W}{f_t}}$$

Applying this to the case of a series of hooks ranging from the minimum to the maximum to be manufactured, a standard form of section may be laid out as in Fig. 1, and the constant established. For the hooks tested by the writer the following values for the constant were found:

30-ton hook, cast steel.....	3.00
30-ton hook, cast steel.....	3.10
15-ton hook, cast steel.....	3.23
15-ton hook, wrought iron.....	4.29
10-ton hook, cast steel.....	3.49
10-ton hook, wrought iron.....	3.42
5-ton hook, cast steel.....	3.12
5-ton hook, wrought iron.....	3.12
3-ton hook, cast steel.....	3.78
2-ton hook, cast steel.....	3.74
Average	3.43

To make the case representative of present practice let such ratio of proportions be assigned to the section shown in Fig. 1 that $C = 3.4$. The design of a series of wrought iron hooks to sustain loads of from 2 to 40 tons with a limiting intensity of tensile stress of 30,000 pounds per square inch will require the following computations:

$$40\text{-ton hook}, r = 3.4 \sqrt{\frac{80000}{30000}} = 5.54$$

$$30\text{-ton hook}, r = 3.4 \sqrt{\frac{60000}{30000}} = 4.7$$

$$20\text{-ton hook}, r = 3.4 \sqrt{\frac{40000}{30000}} = 3.94$$

$$10\text{-ton hook}, r = 3.4 \sqrt{\frac{20000}{30000}} = 2.76$$

$$5\text{-ton hook}, r = 3.4 \sqrt{\frac{10000}{30000}} = 1.95$$

$$2\text{-ton hook}, r = 3.4 \sqrt{\frac{4000}{30000}} = 1.23$$

The proportions obtained above will be for loads giving a maximum stress at the elastic limit of the material. For cast steel different values will necessarily be obtained. The establishment of such a standard would lead to a very simple process for the determination of the principal section of a hook for any capacity; the proportions of the shank and other parts of the hook may readily be established on the same basis. The bottom of the hook, being subjected to much wear, cannot of course be proportioned on the basis of the stress analysis. The above standard section selected as an average representative of present practice is not, however, the most economic form of section from the standpoint of equal maxi-

ANALYSIS OF HOOKS TESTED

Load at Elastic Limit, Pounds

Rated Capacity	30-ton Cast Steel	20-ton Cast Steel	15-ton		10-ton		5-ton		3-ton	2-ton
	Cast Steel	Wrought Iron	Cast Steel	Wrought Iron	Cast Steel	Wrought Iron	Cast Steel	Wrought Iron	Cast Steel	Cast Steel
By test.....	56,000	30,000	48,000	16,000	18,000	16,000	18,000	14,000	8,500	4,700
By standard formula.....	115,000	70,000	145,000	73,000	43,000	26,000	52,300	20,800	14,900	14,900
By new formula.....	55,080	29,925	50,570	15,000	16,500	15,000	18,950	14,100	8,600	4,400

mum tensile and compressive stresses. It has been pointed out by Professor Pearson that a section with such proportions is approximately an isosceles triangle with a radius of curvature of 1.75 of the height. The more nearly this form could be approached, the less would be the weight of hook.

Professor Goodman points out that for hook sections the functions γ_1 and γ_2 are expressed approximately as follows:

$$\gamma_2 = \frac{ke}{1.2 \rho^2}$$

$$\gamma_1 = 1 + 1.1 \gamma_2$$

where k = radius of gyration of the sections, the other symbols being as before noted.

In applying these empirical formulas to punch and riveter frame sections the writer has found that the results are not accurate, but that the values are better expressed as follows:

$$\gamma_2 = \frac{ke}{0.7 \rho^2}$$

$$\gamma_1 = 1 + 1.1 \gamma_2$$

For example, consider the design for a punch frame shown in Fig. 2. Computing the values for the functions γ_1 and γ_2 by the empirical formula, $\gamma_1 = 1.44$, $\gamma_2 = 0.4$. Whereupon the intensity of stress according to the new method of analysis for a force of 90,000 pounds at the punch will be

$$f_t = \frac{W}{A} \left\{ \frac{l}{\rho \gamma_2} \left(\frac{1}{\left(1 - \frac{e}{\rho} \right)^{\frac{1}{2}}} - \gamma_1 \right) + 1 \right\} = 8500 \text{ pounds per square inch, approximately}$$

According to the old formula used almost exclusively in text books, the value of f_t is expressed by $\frac{W}{A} + \frac{Wle}{I}$, whence

$f_t = 2,450$. It may be clearly seen that were the punch in question designed for a limiting intensity of stress of 2,450 by the old formula, there would actually be a maximum stress of 8,500 pounds per square inch, which is hardly a safe value for cast iron and particularly for a large casting.

The above empirical formulas are derived from the results of computation of two sections and may not work out as correctly in all cases.

ASSEMBLING A 48-INCH MOTOR-DRIVEN PLANER*—1

ALFRED SPANGENBERG†

In planer erection, the principal points to be observed are that the housings must be parallel with each other and square with the bed; accuracy is essential in the fit of all sliding members and in the truth of all plane bearing surfaces; the gears should mesh properly and run smoothly; and the system must be such as to permit the various parts to be easily and quickly assembled, and avoid the necessity of fitting the members together for the laying-out operations. This, of course, presupposes the employment of jigs and gages, but, owing to the fact that planers of the 48-inch size and upwards are seldom built in large numbers at a time, and further, that there are many different types of drive, it is impracticable to indulge very freely in the use of elaborate jigs for duplicating the larger parts. However, many of the members used in the construction of planers are common to several different sizes and different types of drive, so that with a

the latter are controlled to a great extent by the former, a brief description of the points to be observed in machining, together with the gages used for testing the larger members, will be illustrated and described. Referring to Fig. 2, *A* indicates a gage for testing the V-surfaces on both the bed and table, it being shown in position on the latter. The surfaces *B*, which support the gage, are finished first, and in this way the gage is always kept in a horizontal plane and both tracks are the same width, so that when the table is placed in position on the bed, the top of the table will be square with the housings. Another advantage of this gage over the usual form having a bearing on both sides of the V, is that only two parallel surfaces are finished and tested at a time, which often saves changing the planing tools and resetting the tool-heads. The gage is squared by trying a 0.001-inch feeler on both sides of the gage as at *C* and *C*₁. To determine the width of the V tracks on the bed and table, measurements are taken at *D* and *D*₁, respectively.

The gage just described is not adapted for measuring the rack seat, however, and therefore another gage is provided

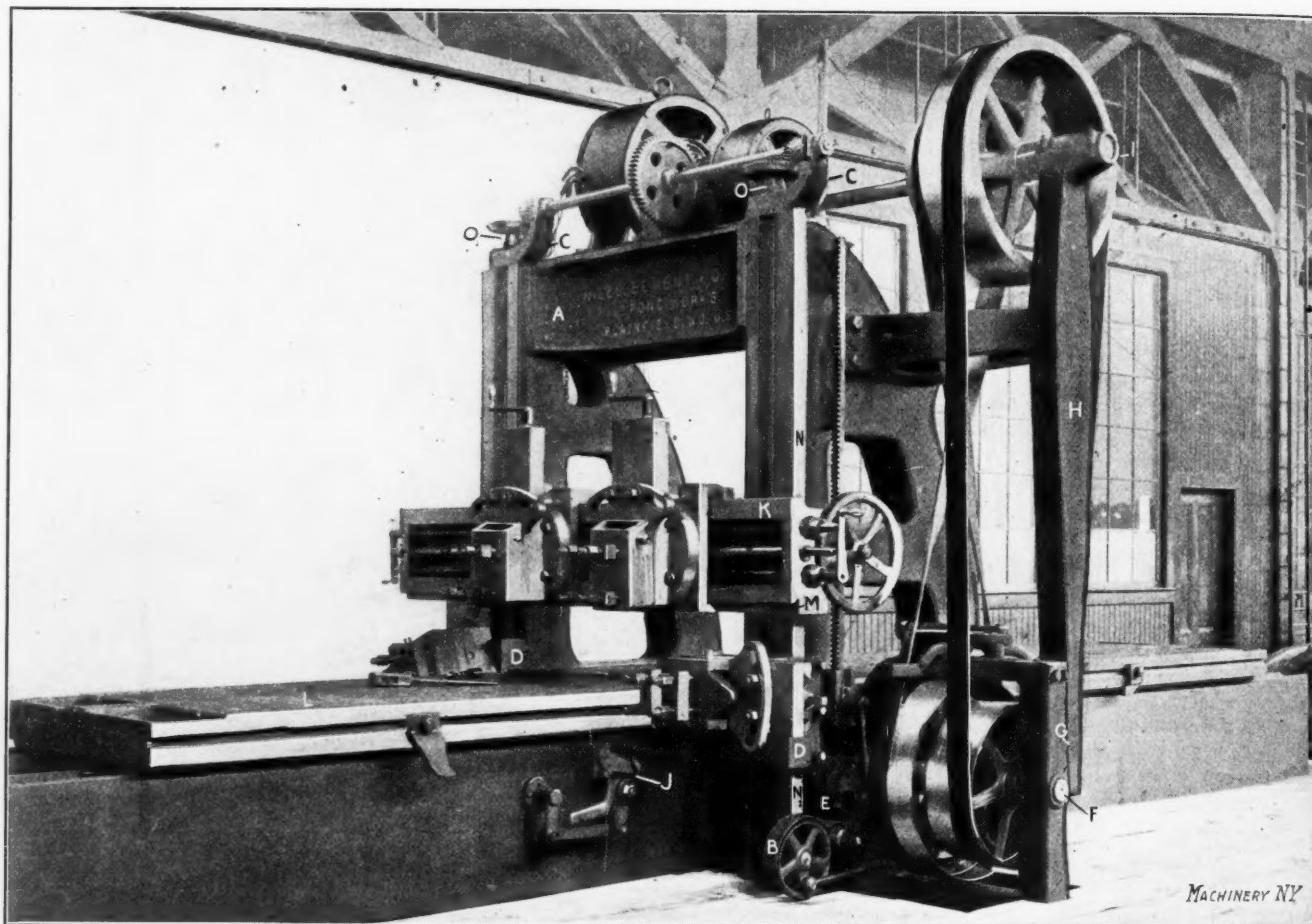


Fig. 1. Forty-eight-inch Motor-driven Planer, used as Example for Illustrating Principles Involved in Assembling Planers

few very simple jigs and gages, the standard members can be made interchangeable, and in this way much expensive handling in laying out, and the consequent lost time, is avoided.

This article will deal principally with the erecting process on the bed, since the methods and processes employed in assembling the smaller units do not differ greatly from the practice used in assembling those of other machine tools. All the principles involved in the erection of a small planer are encountered in the case of a large machine, and many other complicating factors are added; hence, the erection of a planer of the latter class will be described in detail. For this purpose a 48-inch motor-driven planer is selected, the general features of which are immediately apparent from a study of the half-tone Fig. 1.

As the machining processes are so intimately correlated with those of assembling, and as the methods employed in

which fits both sides of the V's, and is represented by the dotted lines. This gage carries a slide *E* which measures the rack seat. At *F* is shown a sheet iron support which fits either gage and prevents it from tipping over.

In the same illustration, at *G*, is shown the method of testing the table on surfaces *H* and *H*₁, which have a clearance of 0.005 inch between corresponding surfaces on the bed. As will be seen, the cast iron gage block *I* fits the V on the table and is provided with two surfaces, one, *J*, for setting the planer tool, and another, *K*, for testing surface *H* after the finishing cut is taken. To the right, at *L*, is shown another cast iron gage, this being used for setting the tools and testing the surfaces *M* and *N*; at *L*₁ the gage is shown in position in the V track of the bed. As will be pointed out later, the object of finishing the surface *N* last is to provide a locating surface for the jig for boring the bed. In this way, the rack gear shaft hole is bored the correct distance from the V tracks, so that when the table is in position, the table rack will mesh properly with its gears. Length gages *O*, *P*, *Q*, and *R* are for testing the measurements indicated, the latter also

* For additional information on this and kindred subjects, see "Assembling a 24-inch Engine Lathe," in the November, 1909, issue of MACHINERY, and articles there referred to.

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being used for taking the length of the arch *A*, Fig. 1.

It is essential, of course, that the housing cheeks on the bed be perfectly square with the V-tracks and parallel with each other. To accomplish this, the sweep *S*, carrying the Starrett indicator *T*, is used in connection with the straight-edge *U*, which reaches across the bed and extends a sufficient amount beyond one side to accommodate the swing of the indicator. By this means very accurate results are obtained. The operator holds the bar *V* in contact with the bed, and the flanged bearing *W*, being of ample diameter and ground true with the bar, keeps the bar in a vertical plane.

Boring and Drilling the Bed

The bed, having passed inspection with regard to the accuracy of the planing operations, is now sent to the horizontal boring and drilling machine where all the boring, drilling, and tapping operations are completed; one setting only is required, as the machine is provided with two separate columns carrying spindle heads, both working on each side of the bed simultaneously. In the line-engraving Fig. 3 the bed is seen resting on parallels *A* with the jig *B* in position ready for the operations just mentioned. As will be observed from the top view, the jig consists of three main castings *C*, *D*, and *E*, respectively, which are bolted to the three cast iron tie bars *F*; this construction permits adjustment of members *D* and *E* to compensate for beds having different widths over the housing cheeks. The jig rests on the top of the bed, and is located endwise with reference to the jig members *D* and *E* matching the bed casting, so that when the housings, which have been drilled by a separate jig, are bolted onto the bed, the castings will match properly. Set-screws *G* square the jig with the bed by holding the jig against surface *H*. Suitable stops, straps and bolts secure the jig and bed to the base-plate during these operations.

For boring and reaming the shaft holes *I*, *J*, *K*, *L*, and *M*, two boring bars having suitable cutters and reamers are used, similar to those shown in an article on Jigs and Fixtures, in MACHINERY, March, 1909, issue, Figs. 137 and 142, except that in the present case a middle support enables each bar to carry two cutters and two reamers. The jig is provided with removable hardened steel drill bushings for the housing bolt holes *N*, the tapping being accomplished at the same setting of the spindle. Drill and reamer bushings are used at *O* and *P*, while a fixed drill bushing *Q* permits a small hole to be drilled for the taper dowel pin, ample stock being left for reaming after the housings are bolted on and properly located. After the boring and drilling operations are completed, the bed is moved over to the erecting foundation where the erecting process proper begins.

Drilling the Housings

In Fig. 4, the front housing is shown at *A*, with jigs *B* and *C* in position for

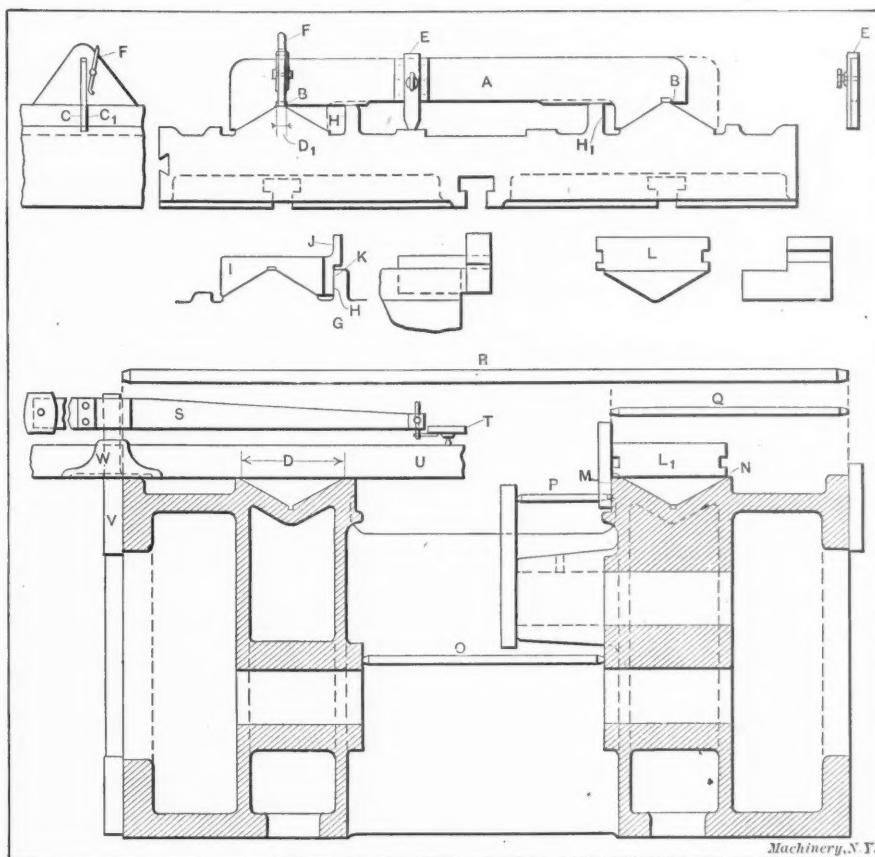


Fig. 2. Gages used for Testing Planing of Bed and Table

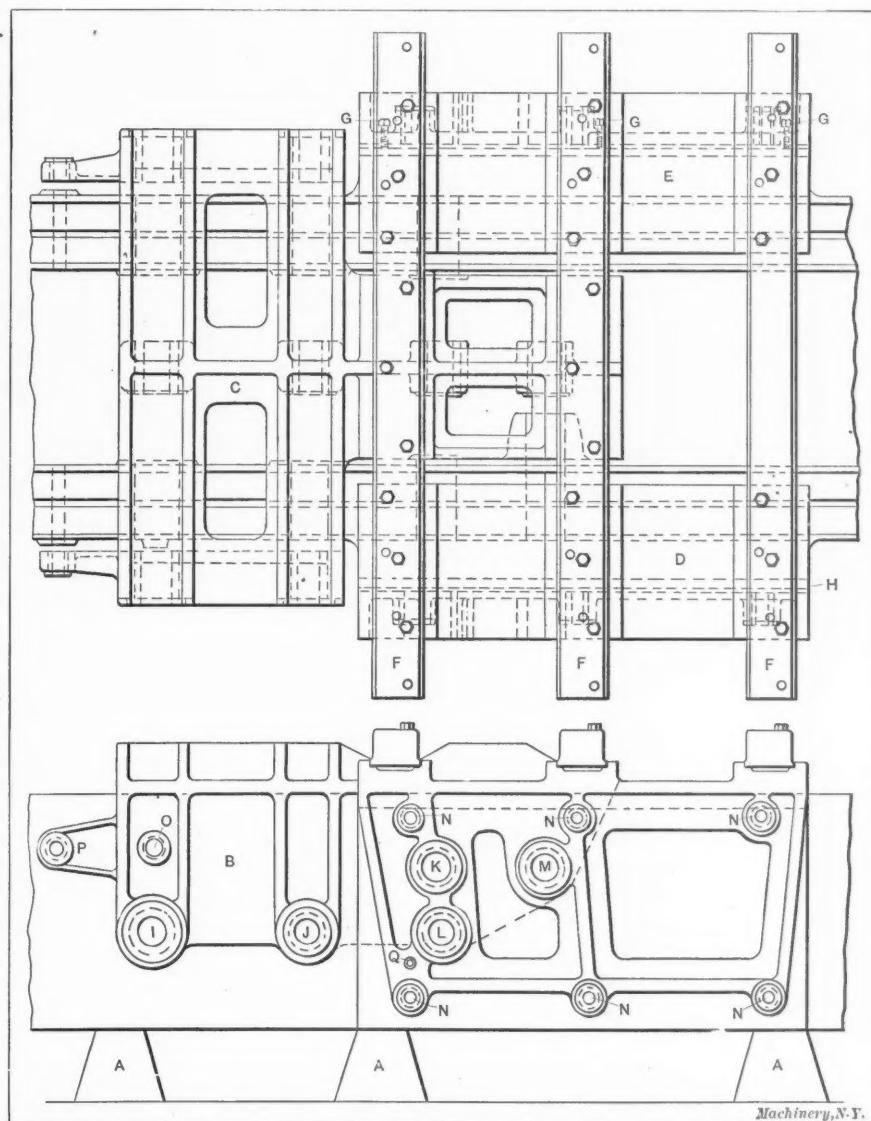


Fig. 3. Combination Boring and Drilling Jig in Position on the Bed

drilling the cheek bolt holes and the arch seat tap holes, respectively; the same jigs are used for the back housing, and jig *C* is also used for drilling the arch casting. The locating points and method of clamping the jigs are indicated in the engraving; as a matter of precaution, after the first hole is drilled in each case, a pin is inserted through the jig bushing into the drilled hole, thus preventing the jig from moving.

All drilling and tapping on this side of the housing being completed, jig *C* is removed, while *B* is secured by four bolts *D* having round heads fitting in place of the drill bushing collars, after which the housing is turned over in the position shown in Fig. 7. The drilling operations are performed on a cast iron base plate provided with a portable motor-driven radial drill, this base also serving the purpose of a surface plate for laying out the work. It is important that the driving shaft bracket hole *A* and feed box shaft hole *C* line up nicely with corresponding holes in the bed, so that the shafts will run perfectly free when assembled. In order to accomplish this without having to assemble the members and housing on the bed, jig *B* is provided with flanged bearings, as at *D*, which support arbors located in the exact center position of the respective driving and feed shafts. The location of the bearings in this jig, and also of the bolt holes *E* is found by clamping the jig to the bed jig member *D*, Fig. 3, and boring the former in this position, so that the two jigs are identical with respect to the locating points and center distances of the various holes.

Referring again to Fig. 7, driving shaft bracket *F* is first centered by the bushing *G* being pushed down into the hole; then the outboard bearing *H* and its member *I* are set approximately correct by means of shaft *J* and jig *K*, and held in this position by C-clamps, after which the truth of bearing *H* with respect to its being square is tested by means of sweep *L*, indicator *M* and test block *N*, as shown in the engraving. When it is determined that bearing *H* is square and properly set, so that bushing *O* enters the hole in jig *K* without springing the shaft, all the clamping bolt holes are marked off, the brackets removed, and the holes drilled and tapped; then the brackets are bolted on, reset in the same manner, and the dowel pins fitted. In setting and testing these bearing brackets, particular care is exercised to insure the accuracy of the work, thereby saving much time when assembling the parts. As was stated at the outset, the fact that these driving works generally are of a special nature, is the reason jigs are not provided for each individual member.

The cam operating lever bracket *P* is marked off, after being set lengthways to the correct dimension *Q*, and sideways so that the center line of its shaft will coincide with a line laid off on the housing the right distance from surface *R*. A simple jig for drilling the feed rack casing holes is shown at *S*, the method of locating and clamping it being immediately apparent. Jig *T* is for drilling the feed-box clamping

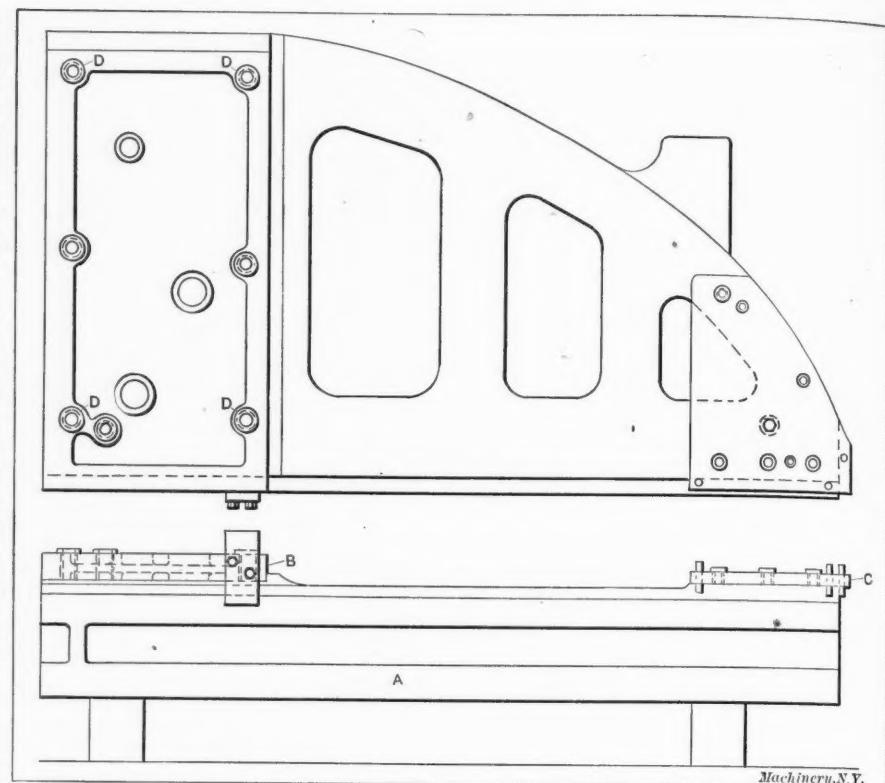


Fig. 4. Front Housing with Jigs in Position for Drilling Clamping Bolt Holes. Same Jigs are used for Similar Operations on the Back Housing

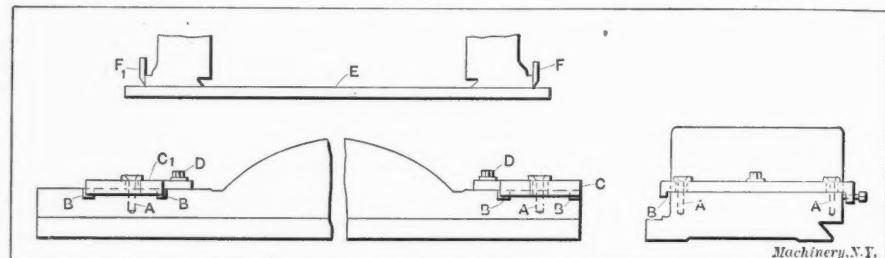


Fig. 5. Jigs for Drilling Stud Holes in Back of Cross-rail. Setting of Jig *C*, Endwise, is accomplished by transferring Measurement from Housings by Means of Wooden Straightedge *E*

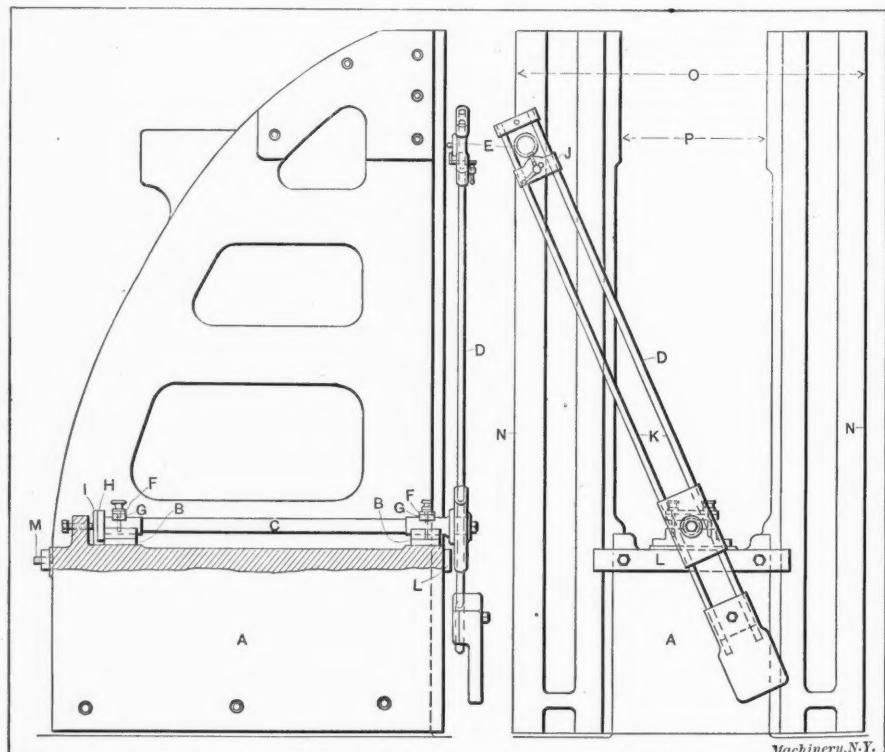


Fig. 6. Special Fixture used for Testing Alignment of Housing Faces and provided with Sweep for Carrying Starrett Indicator

bolt holes; the jig consists of a flat plate centered by means of an arbor the same as at *D*, and located by a pin fitting into housing dowel pin hole *U*. A jig of similar construction and

centered in the same manner, is illustrated at *V*; this jig drills the clamping bolt holes for a bracket that carries the side-head feed shaft. Simple jigs, not shown, are provided for drilling for the feed bracket *B* and elevating screw brackets *C*, Fig. 1, these two operations being performed on a horizontal drill. This completes the drilling on the front housing, and after the necessary drilling is performed on the back housing, using the same jigs as previously explained, the housings are tested to determine the accuracy of the planing.

Testing the Housings

One of the essential requirements of a first-class planer is that it must produce accurate work when using the side-heads, and this means that the ways on the housings be perfectly true and parallel. When making this test, as shown in Fig. 6, the housings occupy the same position as when assembled

face uppermost in a suitable pit for convenience in scraping on the side-head shoes *D*, Fig. 1, after which the housings are ready to be placed in position on the bed.

MODERN CONDENSER PERFORMANCE

Steam engineers in the past have generally considered that, from the standpoints of coal consumption and plant operation, the reciprocating engine gained little from a vacuum above 26 inches of mercury. This opinion was in part due, especially in marine circles, to the practice of driving the auxiliaries from the main engine, so that, there being no auxiliary exhaust to heat the feed, a lower vacuum meant hotter feed water. The steam turbine, however, because of its ability to deal efficiently with steam in large volumes, easily shows a gain of from 5 to 10 per cent in steam economy for every additional inch of vacuum above 26 inches, and the heating of the feed water is properly left to the economizers or to heaters utilizing the exhaust of auxiliaries. The premium thus put upon condenser performance has resulted in a closer scrutiny of the several processes which go on in a condenser.

The activity of the several groups of tubes in a surface condenser can be quite accurately inferred from the rise in temperature of the water passing through them. By inserting thermometers in the water-boxes it has thus been discovered that in the ordinary surface condenser most of the heat is absorbed—that is, most of the steam is condensed—in the first few rows at the top. The transmission of heat through condenser

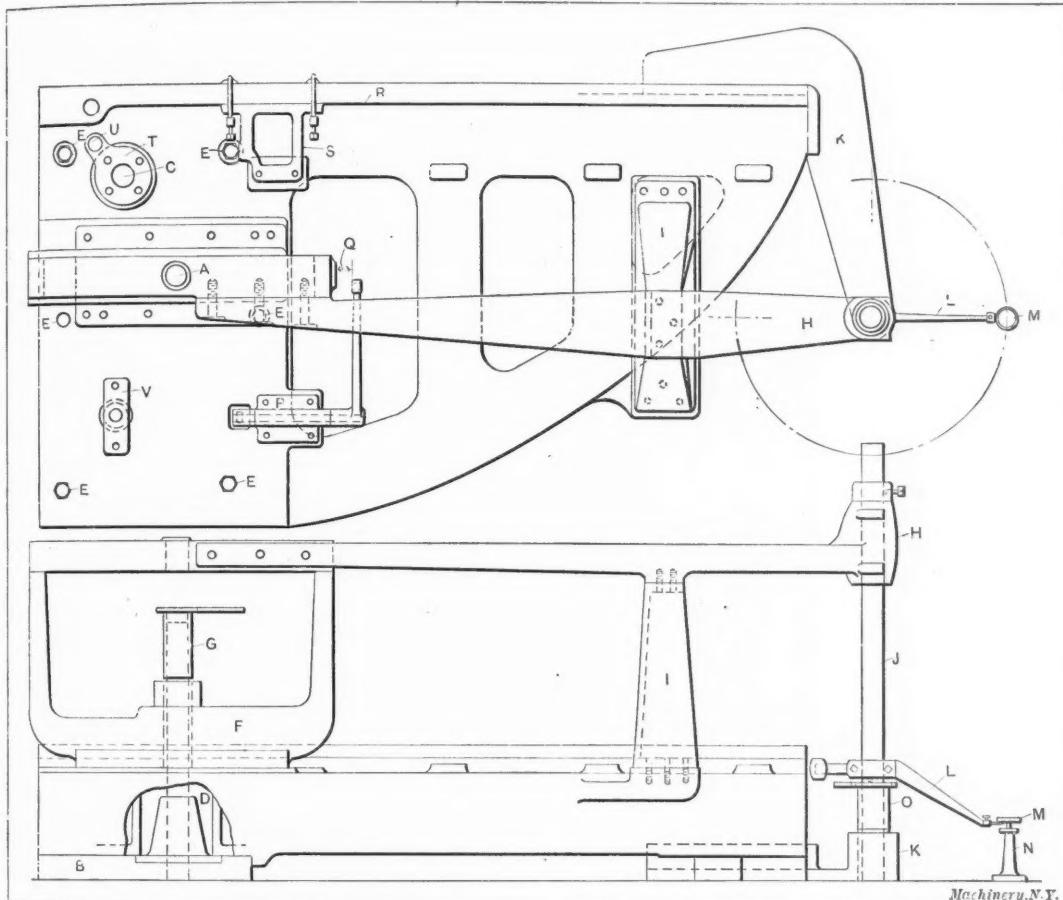


Fig. 7. Method of Setting and Laying out Holes for the Driving and Feed Members on the Front Housing

on their bed, and it is at once apparent that whether or not the front faces stand perfectly plumb, is a matter of little consequence, so long as the faces lie in the same plane. With respect to the side faces and angles, however, the conditions are different; these must be square with the bed. Casting *A* which corresponds to the cheeks on the planer bed, is bolted to a suitable concrete foundation and carries two V-blocks *B*, forming bearings for the sweep bar *C* which in turn supports sweep *D* and indicator *E*. The bar is held in the V-blocks by straps *F* and wooden blocks *G*, while collar *H* and its thrust bearing *I* take up all lateral motion. The construction of sweep proper, *D*, is such that clamp *J*, carrying the indicator, may be secured in any position of its travel between the two seamless steel tubes *K*, which enables readings to be taken at various points.

After being bolted onto the jig, the housings are located against strap *L* by means of screws as at *M*. It is desirable that the front faces show about 0.001 inch low at their outer edges, as at *N*, so that when the cross-rail is in position it will surely have a bearing across the entire face of each housing. Measurements are also taken across *O* at various heights, and between the arch seats *P*, to determine the parallelism of these surfaces. It should be explained that, in the side view, the front housing only is shown for the purpose of more clearly illustrating the sweep bearings. The housings having passed inspection in this test, are next turned

tubes may be affected by the flooding of the lower tubes by the water descending from those above or by the tubes being immersed in air. The velocity of the steam and of the circulating water, and the cleanliness of the tubes, are also governing factors.

While much scientific investigation has been devoted to the effects of water velocity and of steam velocity, the possibilities of improvement in this direction are limited by the fact that excessively high steam velocities mean back pressure while high water velocities involve the consumption of an excessive amount of power in the circulating pumps. The avoidance of air-drowning and of the flooding of the tubes has, however, resulted in greatly reducing the amount of condenser tube surface for a given amount and temperature of circulating water; that is, with the same surface, less, or water of a higher temperature, will maintain the same vacuum.

Air-drowning is prevented by avoidance of air leaks, provision of sufficient air pump capacity and arrangements for removing the air at the lowest possible temperature and hence at the greatest density. The flooding of tubes has been met in various ways. To avoid this flooding effect, the four "Dry Tube" condensers, installed by the Wheeler Condenser and Engineering Co. in the Williamsburg power station of the Transit Development Co. of Brooklyn, are equipped with horizontal baffle plates which are interposed between the sev-

eral banks of tubes. The exhaust steam from the double-flow Westinghouse turbines installed on the floor above, enters the condensers at the top and upon condensing falls upon these baffle or rain plates, which catch the water and carry it to the outside against the shell, down which it flows to the hot well without coming in contact with other tubes. To permit the passage of the steam past these rain plates there are openings, around the edge of which the plate is turned up to form a vertical lip, preventing an overflow of water. These openings are so staggered that the steam will reach all parts of the tubes, insuring complete utilization of all the surface. Simple as this expedient appears, the results obtained by means of it have been remarkable, as will be apparent from a consideration of the rate of heat transfer developed in this condenser under working conditions. It was formerly customary to assume the rate of heat transfer through surface condenser tubes, closed feed water heaters, and similar appliances as between 200 and 300 British thermal units per square foot per hour per degree difference of temperature between the water inside the tubes and the steam outside.

After a series of tests of one of the condensers in the plant referred to, which was designed to handle 180,000 pounds of steam per hour and to give a vacuum equivalent to 2 inches absolute pressure with 70 degrees F. circulating water, the transmission of heat per square foot per hour per degree difference of temperature was found to be between 800 and 900 British thermal units which is two to three times greater than is obtained from the ordinary surface condenser. During the tests the rate of condensation varied from 164,586 pounds to 220,200 pounds of steam per hour. These results show that the guaranteed vacuum could have been maintained with even less condensing surface than was actually installed, although the latter is considerably below usual practice. That is, while the ordinary condenser would contain 2 or 3 square feet of surface per rated horse-power, this condenser contains only 1.5 square foot per rated electrical horse-power.

With the jet condenser, it is not so much a question of improving the rate of heat transmission as of insuring thoroughness of intermixture, that is, of bringing each particle of water so intimately in contact with the steam that it will be heated to the steam temperature and its full capacity for absorbing heat realized. This is desirable in order to reduce the amount of circulating water and to prevent loss of temperature in the hot well. By reducing the amount of circulating water, the power required for pumping it is minimized and less air is brought into the condenser. At first thought it would seem an easier and simpler matter to secure high temperature in the circulating water leaving a jet condenser than in that leaving a surface condenser, since in the jet condenser the water and steam come into actual immediate contact; nevertheless, the fact remains that the water discharged from most jet condensers does not rise nearer than to within 10 to 20 degrees F. of the temperature of the steam.

The results of tests of a Wheeler "Rain Type" jet condenser connected with a Westinghouse-Parsons 1,000-kilowatt steam turbine are given in the accompanying table.

Vacuum, inches	Absolute Pressure, Ins. Mer.	Corresponding Temp.* of Exh. Steam	Injection Temperature In Out	Difference in Temp. of Steam and Cir. Water
28.65	1.25	85.5	44 85	0.5
28.7	1.2	85.	44 85	0.0
28.7	1.2	85.	44 83	2.0
28.75	1.15	83.5	44 80	3.5
28.75	1.15	83.5	44 81	2.5
28.55	1.35	88.5	44 87	1.5
28.75	1.15	83.5	43 79	4.5
28.75	1.15	83.5	43 76	7.5

* Temperatures given in degrees Fahrenheit

As will be seen, the outgoing circulating water kept within from $\frac{1}{2}$ to $\frac{7}{2}$ degrees of the temperature corresponding to that of the exhaust steam. This condenser is of a new design and is so constructed that the steam enters through an opening at the left, passes horizontally across through a shower of water, ascends to the second level, passes to the left through an upper shower, and finally all that is left of the steam vapor together with the air, and other gases, passes horizontally to the right, and over the entering and coldest

water at the top to the dry vacuum pump suction opening in the uppermost part of the shell. The water is introduced at the upper right hand corner into an extended trough or pan, from which it overflows through numerous short tubes, falling into a second and similar pan provided with similar overflow pipes and weir, and finally falling into the lower part of the shell, and overflowing thence to the barometric column or to the centrifugal or other type of pump serving to overcome the atmospheric pressure. The water is finely divided by small baffle plates hung below the tubes.

On the day of the test, the barometer stood at 29.9 inches, while the street railway load on the turbine varied from full load to 10 per cent overload. Temperature readings were taken by thermometers placed in the exhaust pipe and in the hot well, while the vacuum readings were taken from a mercury column connected directly to the condenser. The number of pounds of circulating water required to condense 1 pound of steam was found by calculation to be 24.3. As a matter of fact, the amount would be less than this, since not all of the exhaust is steam when it arrives at the condenser, some of it having already condensed in the turbine and in the exhaust pipe, due to work performed and to radiation.

* * *

LENGTH OF RECESS IN THE BORE OF MILLING CUTTERS

The accompanying table has been compiled with a view of giving at a glance the length of recess in the bore of milling cutters, including cutters from one-half inch width of face up to cutters six inches long. It will be seen, by studying the

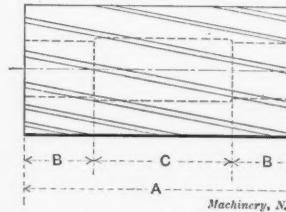


TABLE GIVING LENGTH OF RECESS IN THE BORE OF MILLING CUTTERS

Length of Cutter	Length of Bearing at Each End			Length of Cutter			Length of Bearing at Each End			Length of Recess		
	A	B	C	A	B	C	A	B	C	A	B	C
1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
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INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—2

THE LODGE & SHIPLEY MACHINE TOOL COMPANY
ETHAN VIALL*

The names of Spring Grove and Colerain Avenues become very familiar to the man who visits the Cincinnati tool and machine tool shops—more so perhaps than the names of any



Fig. 1. Paved Court at the Lodge & Shipley Plant for Teaming Purposes

other streets there, for some of the best-known machine tool building shops in the world are easily reached by taking the cars that run from Fountain Square in the heart of the city



Fig. 2. Lathe Bed Storage House with Traveling Crane and Sliding Doors along the Side

out along these two avenues. It is worth while for any mechanic who can possibly do so to take the time to go through a few of these shops at least, and all of them if he can, and naturally, even if only a few were selected, he would not overlook as large and well-known a plant as that of the Lodge & Shipley Machine Tool Co., at 3055-3065 Colerain Ave., which makes nothing but lathes and lathe attachments or fittings, and where he will be given a hearty welcome and a guide who will show and explain everything to him that is worth while. In a trip through this plant, a reader of *MACHINERY* would see many old mechanical acquaintances in the line of tools and methods that have been introduced to him from time to time through these columns, yet there are many things to be seen which have never been described and many things impossible to describe—adequately at least. The present article does not aim to go very deeply into descriptions of shop methods or practice, but simply to present a few of the "high spots" touched here and there in a recent tour of inspection.

System and neatness prevail everywhere and many time-and labor-saving devices are to be found on every hand. The old way for a workman to get the big traveling crane, by going out in the runway, waving his arms like a windmill and yelling until he was hoarse, at the sleepy crane operator two or three hundred feet away, has all been done away with, and now the workman presses one of the buttons set at convenient distances along the shop runway, a red light is flashed

* Associate Editor of *MACHINERY*.

in plain view of the crane man and, unless already employed, he at once runs his crane to where it is needed. Then, too, there is a messenger system in use that obviates the necessity of a machinist leaving his work to get a new jig or tool, as he has only to press a button close to his machine and an annunciator near the tool room indicates to a waiting messenger boy where he is wanted, as all machines are numbered; he then goes at once and finds out what is wanted, gets it for the man and returns to his place ready for another call.

The traveling crane system is unusually complete and is so arranged that castings can be removed from a wagon by the yard crane and stored, or carried within reach of one of the shop cranes. New machines are loaded with the same ease. The court into which the heavy wagons are driven for loading or unloading is shown in Fig. 1. This is well paved and drained and is large enough for several teams to maneuver in at once. In this engraving the main shop is partially shown in the background; shop Number 2 is at the left and one of the storage sheds is in between the two.

In Fig. 2 is shown the way lathe beds are stored, some of these being in the rough, while others are partly finished and left here to "season." Lathe carriages are stored close to the assembling floor in upright racks, as shown at the right in Fig. 3, and compound rests on the iron shelves covered with cloth, shown at the left.

A satisfactory and economical way to stack quantities of round bars of various sizes and lengths, is often a puzzle to the man in charge of stock, but the problem has here been very happily solved, as shown in Fig. 4, by using short lengths of square iron bars curved up at each end and placing them

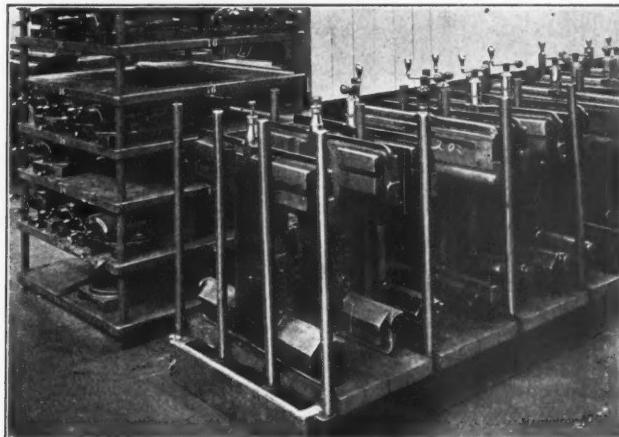


Fig. 3. Racks and Shelves for Holding Carriages and Compound Rests

as shown. Where a rack of some kind is wanted for storing large amounts of stock, a very good type is shown in Fig. 5. This rack has adjustable supports for the cross-pieces, so that



Fig. 4. Method of Piling Round Stock, which is both Convenient and Economical as to Space

compartments, to suit the different sizes or amounts of stock, can be readily arranged.

In the machine shop, a portable motor-driven variable-speed countershaft, shown in Fig. 6, is used to run lathes that are being assembled or tested. A planer equipped with a regular Lodge & Shipley variable-speed lathe countershaft (Fig.

7) is something unusual, but it ought to be very handy for some classes of work.

The hand scrapers used by the assemblers and fitters are sharpened on the portable oil-stones shown in Fig. 8. These stones are motor-driven and may be set in any convenient place close to the machine or machines upon which a group of men may be working.

After the gears and parts of a lathe head are in place, the shift-gear lever-lock holes A, Fig. 9, are drilled in the head-

carrying the work is driven by a universal jointed shaft and set of bevel gears, connected to the countershaft, in the same way that drills in a screw machine turret are independently driven. The work is fed up to the grinding wheel by means of the ball-crank *A*; a rotary movement is given to the table by turning the hand-wheel *B*. The wheel to be ground is fastened on the end of the work spindle by a nut and it is kept from turning by a pin in the face-plate which engages one of the spokes.

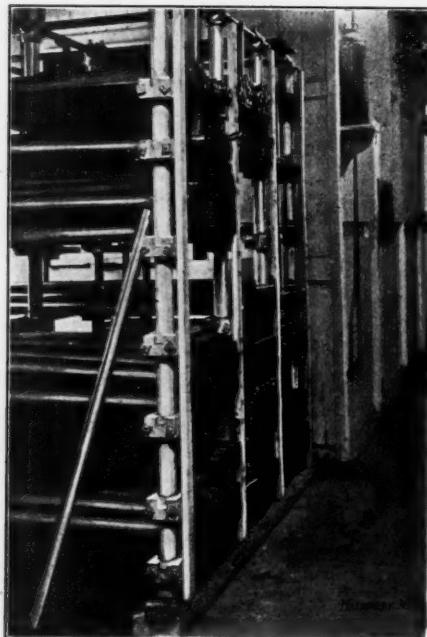


Fig. 5. An Adjustable Storage Rack for the Stock-room

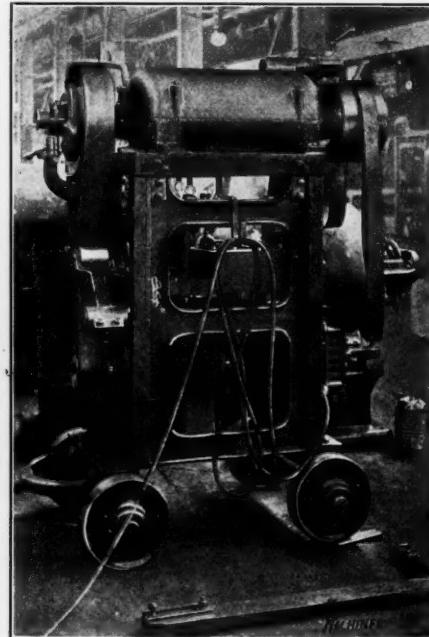


Fig. 6. Movable Variable-speed Countershaft for Testing Purposes

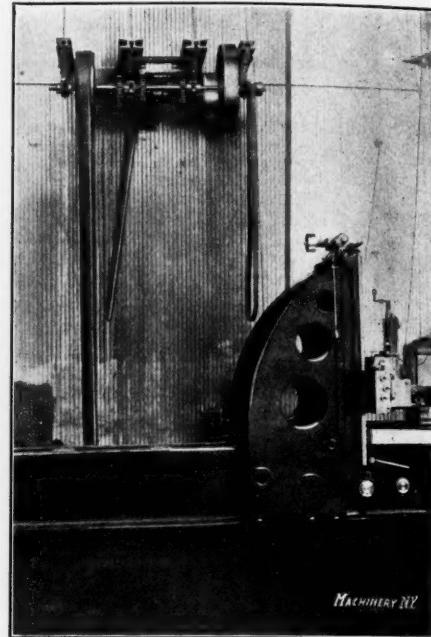


Fig. 7. Planer equipped with a Lodge & Shipley Variable-speed Lathe Countershaft

casting so that they will line up properly with the correct position of the lever and gears. This is done by removing the locking pin from the lever, meshing the gears, spotting each hole to be drilled in turn through the locking pin hole, and then finishing the holes, using the electric drill and adjustable stand shown. Braces and locks to hold the drill to the work for this and other jobs are shown lying on the floor.

The small straightening block or screw-press (Fig. 13) is made considerably lighter than usual by bracing the top with an eye-bolt as shown, which makes it just as good for most purposes. It is also easier to handle because of the decreased weight.

Bushings like *A*, Fig. 14, are screwed into the lathe aprons by taking advantage of the oil groove in them and using it for

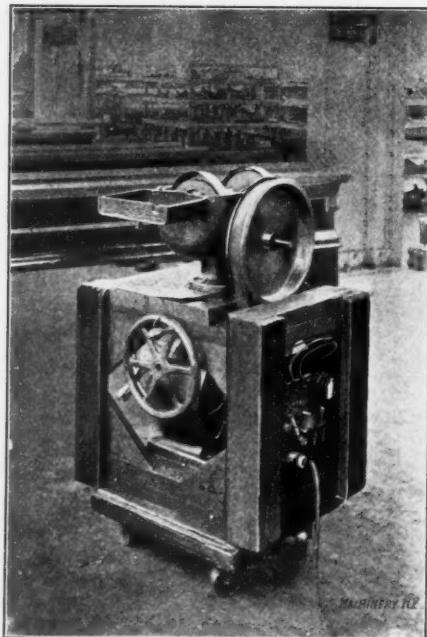


Fig. 8. Portable Scraper Grinder

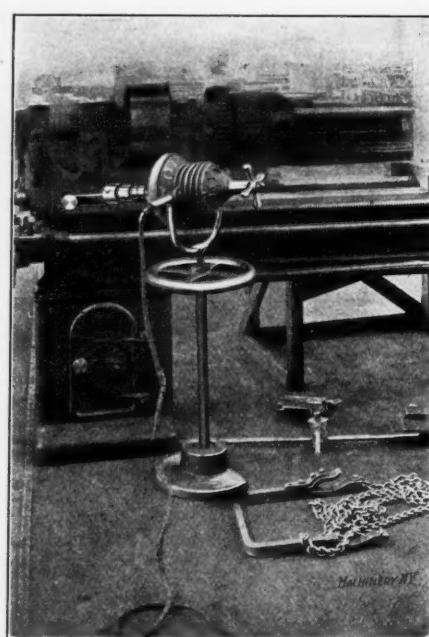


Fig. 9. Adjustable Electric Drill and Brackets

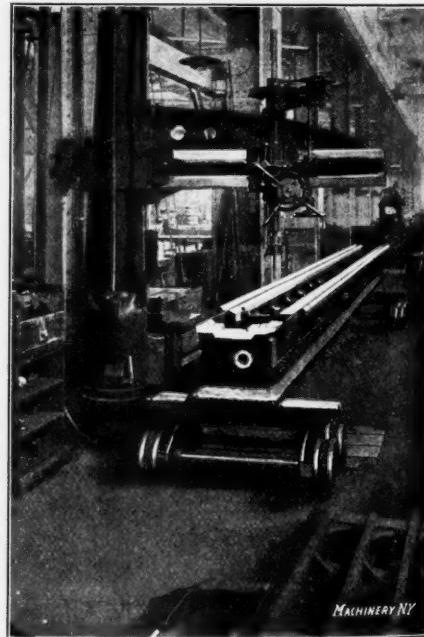


Fig. 10. Drilling Large Lathe Beds

Large lathe beds are placed on the four-wheeled trucks, Fig. 10, while the different holes are drilled with a big radial drill, and in this way the huge castings may be moved along with comparative ease. The ends of these large beds are faced off with the portable milling machine shown in Fig. 11.

Hand-wheels of all kinds have the rims ground on the special machine shown in Fig. 12, which does splendid work and is very conveniently and rigidly built. The emery wheel spindle is run with a belt in the usual way, but the spindle

a wrench-hold, the wrench-plugs *B* being made with a corresponding ridge.

Small reverse-plate gear-bushings are held while turning the outside, as shown in Fig. 15. The mandrel used is fastened securely in the lathe spindle and has a pin or key in it which fits into the oil notch in the bore of the gear-bushing and keeps it from turning. The outer end of the mandrel is supported by the tailstock spindle of the lathe which has been fitted with a bushing for the purpose. This spindle also has

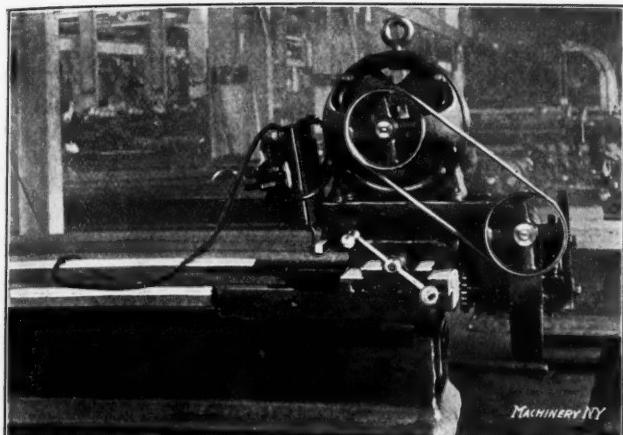


Fig. 11. Portable Milling Machine for Facing Ends of Large Lathe Beds

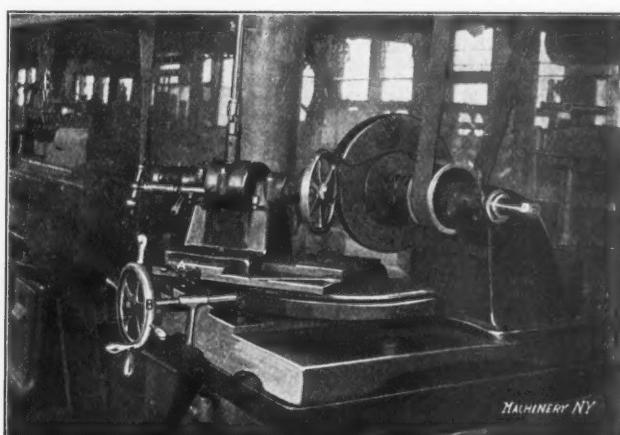


Fig. 12. Special Machine for Grinding Rims of Hand-wheels

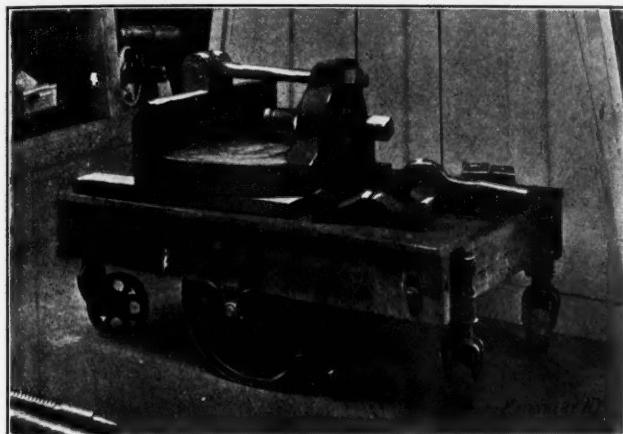


Fig. 13. Straightening Block with Top Brace

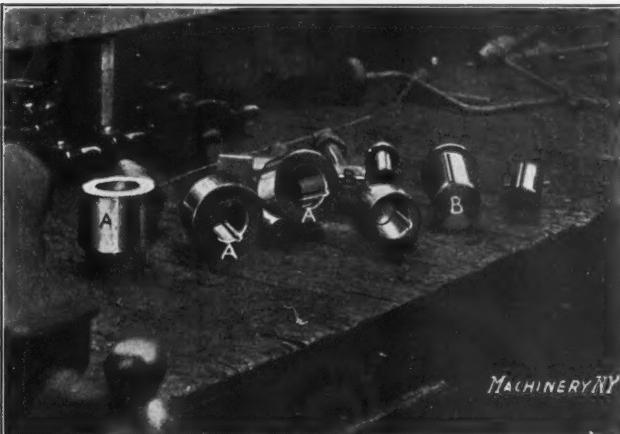


Fig. 14. Apron Bushings and Plugs used for Screwing them in.

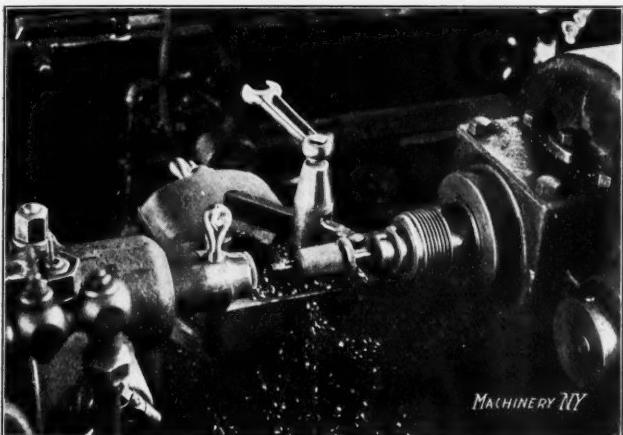


Fig. 15. Special Mandrel used to hold Reverse Plate Gear Bushing

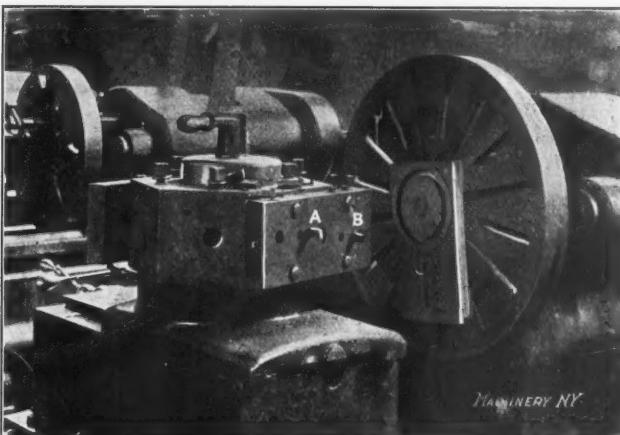


Fig. 16. Cutting T-slots in Lower Compound Slide

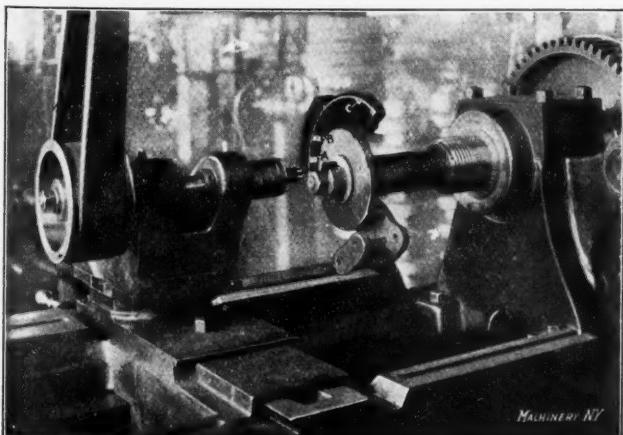


Fig. 17. Milling Contact Spots on Countershaft Friction Parts

a handle attached so that it can be shifted out or in easier while taking off or putting work on the mandrel.

Fig. 16 shows how the circular T-slots are cut in the compound rest bottom-slides. They are located on the face-plate

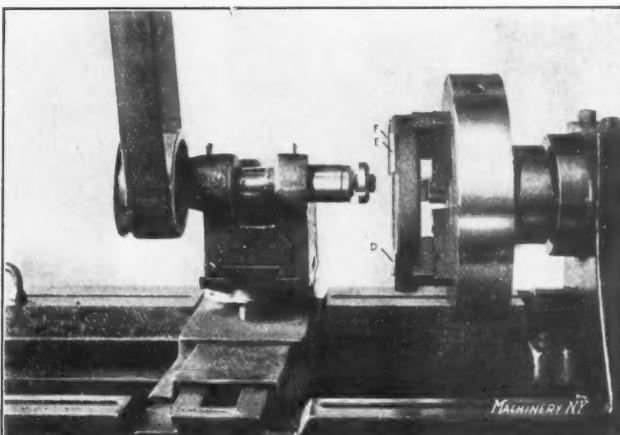


Fig. 18. Milling Friction Bands for Countershafts, in the Lathe

by means of a plug mandrel in the lathe spindle, which fits the hole bored in the casting. The circular slot is cut out by using the two cutters A and B, shown in the turret, and feeding them straight in. The slot is then made T-shape by

using two L-shaped tools set in the turret in a way similar to *A* and *B*. These tools are run in flush with the bottom of the slot which is finished by cross feeding the turret the desired amount.

The "spots" *A*, *B* and *C*, Fig. 17, on the countershaft friction parts, are milled on a lathe, to the carriage of which has been fitted the fixture shown. The friction band is milled at *D*, *E* and *F*, Fig. 18, using the same fixture, with another cutter which machines both the face and outside of the contacts at once while the casting is held in a regular lathe chuck.

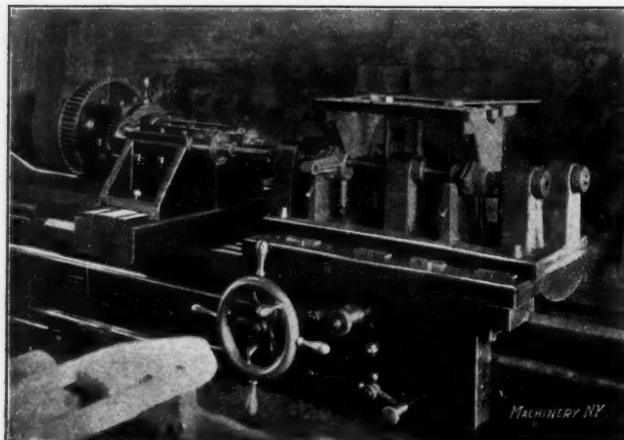


Fig. 19. Jig for boring Countershaft Brackets



Fig. 21. Group of Special Spindle-drilling Machines

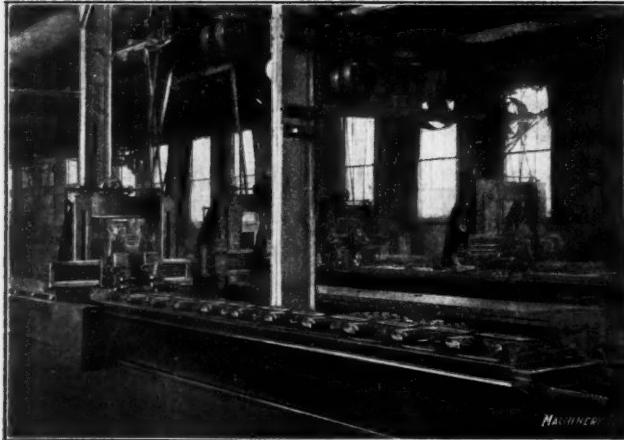


Fig. 23. Planing Lathe Carriages

Countershaft brackets are bored out while held on a lathe in the jig shown in Fig. 19, using a double-headed boring fixture operating two boring-bars at once.

Lathe heads are bored out as shown in Fig. 20. All lathe spindles used in this shop are drilled out of solid metal on the machines shown in Fig. 21. The standard method of rotating the work and feeding in the drill is used in these machines. Lodge & Shipley also makes a motor-driven lathe attachment for deep drilling.*

* Complete information on this subject will be found in MACHINERY'S Reference Series No. 25 on Deep Hole Drilling. A description of the Lodge & Shipley deep hole drilling attachment will also be found in this pamphlet.

Fig. 22 shows the series of jigs used to hold lathe heads on the planer, and Fig. 23 shows a lot of lathe carriages being planed up for the cross-slides.

This article would not be complete without a brief description of a few of the many things that are provided for the comfort and welfare of the employes. In Fig. 24 is given a partial view of the neat washroom with its individual wash basins, and along the walls are shown dust-proof individual lockers for the men's clothing and lunch boxes. Ample space is also provided elsewhere for bicycle storage.

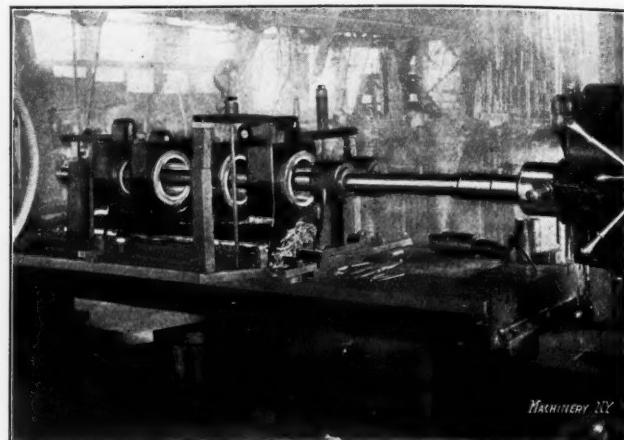


Fig. 20. Boring Lathe Heads

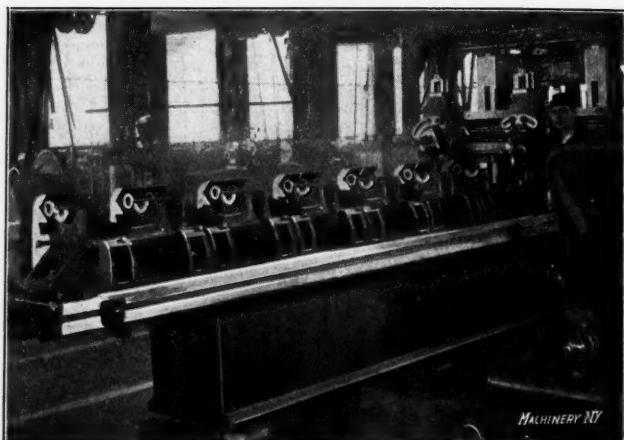


Fig. 22. Fixture for Head-stock Planing

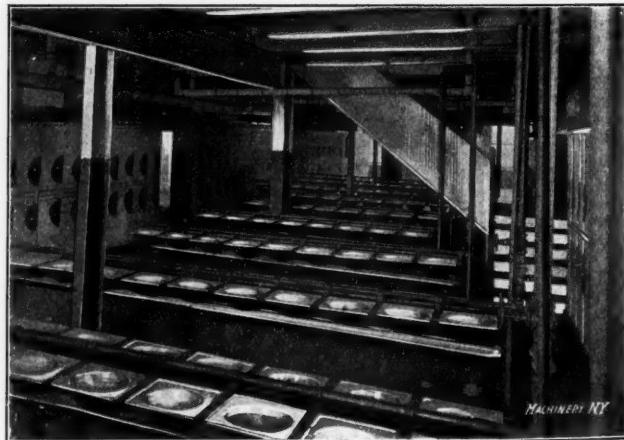


Fig. 24. Employees' Locker and Wash-room

The employes have a mutual benefit association, which for a small sum provides a fair amount of protection for members who are sick or injured.

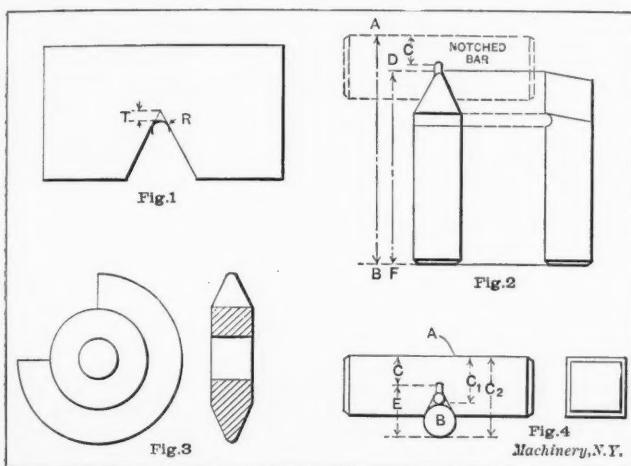
* * *

The electrification of a street railway line in London has been brought to a standstill on account of possible disturbances to the delicate instruments at the Greenwich observatory. The Astronomer Royal has the power to pass upon any undertaking within three miles of the observatory that is liable to affect the instruments, and the railroad company must obtain his consent before proceeding with the electrification.

MAKING WHITWORTH THREAD TOOLS*

In order to produce interchangeability in screw threads, the tools for the screw cutting operations require very careful consideration. Even with accurate tools, the form of thread cut by any threading device depends considerably on the material in which the thread is cut. For instance, a tap used to cut a thread in cast iron is withdrawn with ease, but when the same tap is used in machinery steel it is not as easily withdrawn, the cause evidently being that the threads in the cast iron are thinner and that the pitch diameter of the screw thread is correspondingly increased. This being the case, it is very evident that it is necessary to have the original thread cutting tool as nearly perfect as possible, in order that the subsequent deviations may be minimized. A method is briefly described for generating and measuring thread tools for cutting threads with rounded top and bottom, such as the Whitworth and British Association standard threads.

In the specifications of these standards the radius of curvature, R in Fig. 1, at the top and bottom is given. In originating tools for these thread forms templets are usually made



Figs. 1 to 4. Whitworth Thread Tools and Methods used for Making

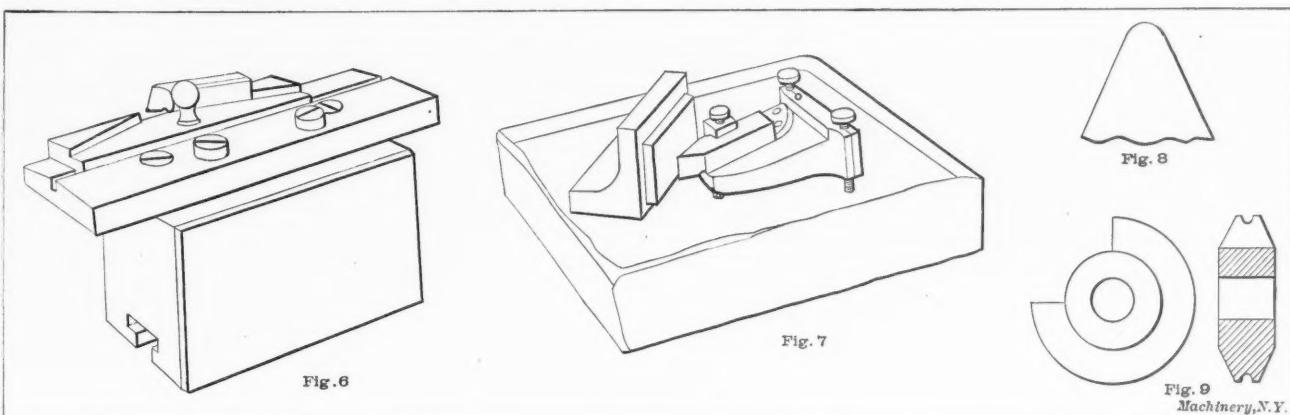
by drilling a round hole of the required radius and cutting an angular notch with sides running tangentially into the hole as shown. Fairly accurate work can be done in this way, but a method originated by Mr. W. Taylor permits of greater accuracy in gaging the angle of the thread tool, this being of more importance than the exact curvature of top and bottom.

In shaping the original thread tool as shown in Fig. 2, a notched bar of hardened steel, as shown in Fig. 4, is used for measuring. The face A of this bar is lapped flat, the V-notch is lapped so that its center is perpendicular to A and

apex of the V-notch. Anyone familiar with trigonometry can easily calculate the dimensions C and E when C_1 , C_2 , the angle of the notch, and the diameters of the cylindrical gages are known. This notched bar is applied to the tool as shown by the dotted lines in Fig. 2, the angular faces of the tool having been previously ground. The total distance AB is measured, and from this we subtract the constant dimension C of the bar and the distance T , Fig. 1, from the rounded surface of the thread to the true apex of the V-point of the tool. We then obtain the required finished length DF , Fig. 2, to which the tool must be shortened by rounding its extreme point.*

In rounding the tool point the radius of the curvature is not directly measured. It is sufficient that the curve be circular, that the angular sides of the tool join it tangentially, and that the distance from the top of the curve to the apex of the tool angle be obtained correctly by measurements as described. The first two conditions above are most easily obtained in circular formed threading tools of the shape shown in Fig. 3, which can be sharpened without losing their form. Cutters of this form are invaluable for constant use, but cutters shaped as shown in Fig. 2 can be made by simple means.

The grinding machine shown in Fig. 5 is used for forming correctly the circular tool. In this the previously shaped and hardened cutter is finished by grinding with a cup-shaped wheel A , which, while rotating, moves in an eccentric circular orbit so it wears truly flat. The cutter H is mounted and rotated on the horizontal spindle B , and while rotating can be swung around a vertical axis C as far as permitted by the stops D and E , which are set so as to limit the movement to the angle of the tool (55 degrees for the Whitworth thread).



Figs. 6 and 7. Appliances for Making a Tool with Rounded Nose or Cutting Point and with the required Clearance Angle, as shown in Fig. 2

so that it has the thread angle required. Its apex is cut away entirely, as shown, and by means of two or more small cylindrical gages placed at B , the measurements C_1 and C_2 are taken, by which the accuracy of the angle may be verified and from which is found the distance C between the face A and the true

* From a paper entitled Interchangeability and Methods of Securing it in Screw Threads, read before the Institution of Mechanical Engineers of Great Britain, by Mr. H. F. Donaldson.

The tool, when ground, is again tested by the notched bar in Figs. 2 and 4.

In Fig. 6 is shown a simple holder with guides mounted on a slide, which serves to support the tool shown in Fig. 2, and

* A description of a method used for measuring, by the micrometer, the amount to be removed from a Whitworth tool having front clearance was included in an article entitled "Measuring Width of Flat on U. S. Standard Thread Tools," MACHINERY, April, 1907.

present it accurately to a flat-faced rotating metal lap so as to grind the angular sides of the tool point. In Fig. 7 is shown a holder with adjustable feet and with a stop against which the tool may be clamped. This is placed upon a piece of plate glass and worked against a small angle plate faced with an Arkansas oil-stone. With these simple appliances, and with the exercise of a little skill, it is possible to round the tool point so accurately that when magnified 100 to 200 diameters and compared with the circular field of a microscope, no error is perceptible. In Fig. 8 is shown a tool point of a British Association standard thread No. 6 rounded in this way, magnified 30 diameters, and correctly copied. In Fig. 9 is shown the form of the tool used to round the top of the threads, the groove not being as deep as that of a full half circle.

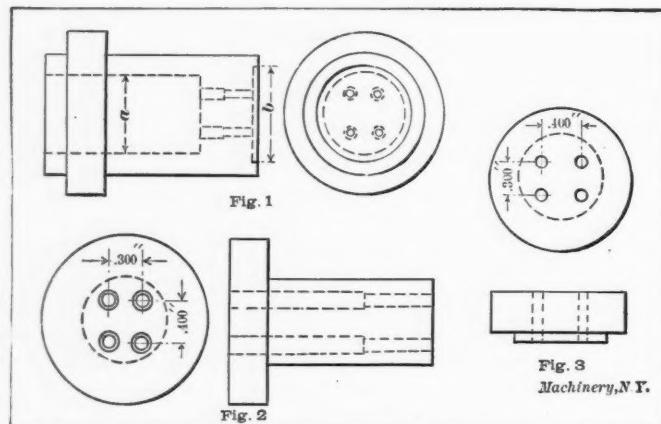
* * *

MACHINE SHOP PRACTICE*

JIG AND DIE WORK IN THE BENCH LATHE - 2

A. L. MONRAD†

Those who read the first installment of this article in the November number will recall that the method of making two small jigs to be used in connection with drilling four holes in the die shown in Fig. 1 was explained. We shall now consider the drilling of this hardened die with a hollow diamond drill, and also the way in which the holes are ground in a bench lathe. Of course, drilling into hardened steel is a



Figs. 1, 2 and 3. Die and Jigs for Drilling

very unusual operation. It was resorted to in this case because of changes in the die, which made it necessary to either drill holes or make a new die. As less time would be required for drilling, this was done, and while the operation is one rarely performed, it will doubtless be of interest to those not familiar with it.

It was first necessary to locate the jigs (shown in Figs. 2 and 3), which had been previously fitted to the die, so that the holes in each jig were in alignment. This was accomplished as follows: First, the jigs were placed in each end of the die which rested in a V-block, one being in hole *a* and the other in recess *b*. This block, in turn, was on an accurate surface plate. Two close-fitting plugs were next inserted in the two upper holes in each jig, and these plugs were then tested with a surface gage until they were all parallel with the surface plate, the necessary adjustments being made, of course, by turning the jigs with relation to the die. When the jigs were correctly set, they were clamped together and then fastened to the die temporarily with a little solder, after which the clamp was removed.

The drilling was done in a sensitive drill press. The die with the attached jigs is shown on the drill press table in Fig. 2. As the work was hardened, the drilling operation was performed with a hollow diamond drill *D*, the end of which was charged with number 4 diamond dust and number 80 alundum. The drill was first charged with diamond dust mixed in sperm oil, by having the diamond on a hardened and ground parallel block and by dropping the drill onto it about a dozen times by a movement of the handle *A*. This pounded the diamond

into the end of the drill. While the drill was being charged, the drill press remained stationary. The drilling operation was performed by dropping a little alundum and then a drop of sperm oil in the hole, and pounding the drill, which was run at a high speed, against the work. The drill was recharged with diamond about every ten minutes. The large or counterbored part of the holes was first drilled to the proper depth with jig *B* guiding the drill. The work was then inverted and the small part of each hole drilled in until it met the larger part, when the small plug *E* in the center dropped down and left a clean counterbored hole.

As the hollow drill will cut a hole a little large, it was made 0.010 inch smaller than the diameter of the small holes (which were 0.052 inch) and this gave sufficient allowance for grinding in the bench lathe, which was the next operation performed. The master-plate *M* with the brass disk *G* attached to it was strapped to the face-plate *F* with the locating plug in the spindle inserted in the central hole in the master plate. A recess was then turned in disk *G* to fit the end of the die as shown in Fig. 5. The die was then inserted in this disk and located so that the four holes in it were approximately in alignment with those in the master-plate. The die was then soldered to disk *G*, which, it will be remembered, was provided with elongated slots for the clamping screws. A diamond lap was used when grinding the small holes. This lap *N* was made of tool steel and was charged with number 2 diamond dust and sperm oil by being rolled between two hardened and ground blocks.

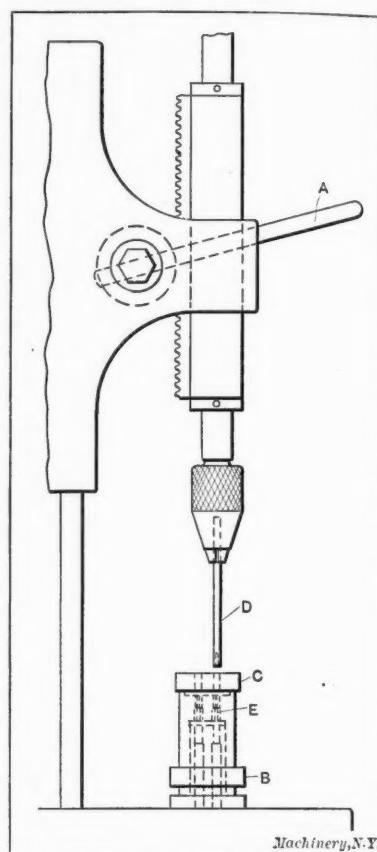


Fig. 4. Sensitive Drill Press with Hollow Diamond Drill and Work in Place

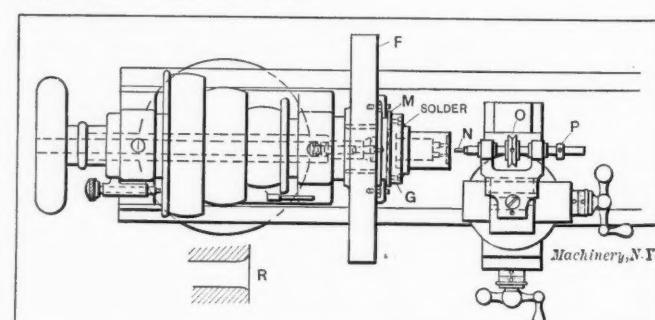


Fig. 5. Finishing the Hole in a Bench Lathe with a Diamond Lap

When grinding holes in this way, the lap should run at the highest speed that can be obtained and the die at the slowest. The feed may be obtained by placing the forefinger and thumb on the sides of the wheel *O* and pushing the grinder spindle back and forth at a moderate speed. Care should be taken to prevent the ends of the holes in the die from being ground "bell-mouthed," that is, rounding at the end as shown enlarged at *R*. This will not occur if the stop *P* and the wheel *O* are located so that the lap cannot move clear of the hole. It will be seen that if the lap were to leave the hole at the end of the stroke, there would be more or less springing action on the part of the lap, which, when it entered the work on the return stroke, would tend to grind the end of the hole rounding.

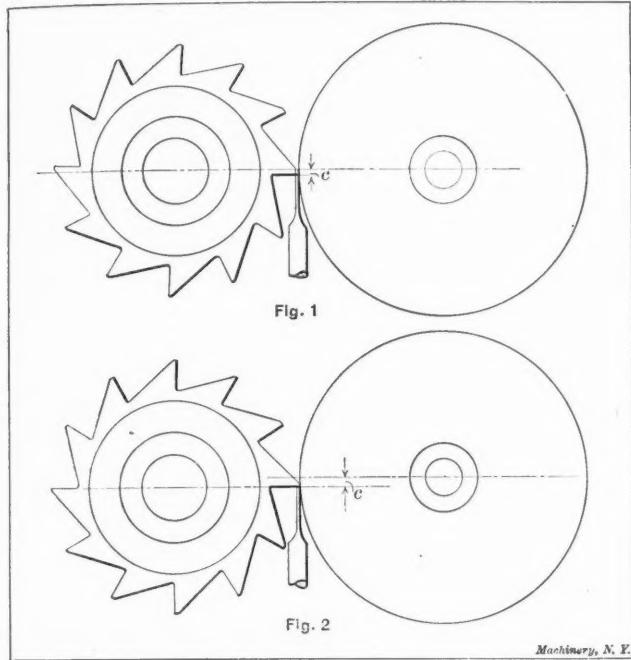
* With Shop Operation Sheet Supplement.

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ERRORS IN GRINDING TAPERED REAMERS AND MILLING CUTTERS

H. A. S. HOWARTH*

There are two distinct methods that are commonly used for grinding the clearance on reamers and milling cutters. These methods involve the relative positions of the axis of the reamer, the grinding wheel spindle, and the guide finger. The first method is shown in Fig. 1, with the axes of the reamer and the wheel spindle in the same horizontal plane. The



Figs. 1 and 2. Common Methods used for Grinding Clearance on Reamers and Milling Cutters

finger is set so that the cutting edge of the reamer lies at sufficient distance below this plane to give proper clearance or backing off. The amount of clearance is decreased by raising and increased by lowering the finger.

The second method is shown in Fig. 2 with the axis of the reamer in the same horizontal plane with the cutting edge, i. e., with the end of the guide finger; but the wheel spindle is above this plane a variable amount governed by the clearance desired. As the wheel is raised the clearance is increased and vice versa. Cylindrical reamers or cutters can be accurately ground by either of these methods, whether the flutes are straight or spiral; but tapered reamers or cutters cannot be ground accurately by the first method; they can,

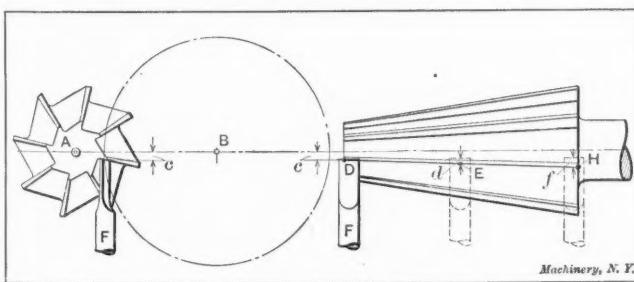


Fig. 3. Illustration showing Conditions when Grinding a Taper Reamer by Method shown in Fig. 1

however, be so ground by the second method. Because of the extensive use of the first method it is the purpose of this article to prove its inaccuracy and to discuss the errors introduced in grinding tapered reamers and cutters. The actual error will be calculated for a number of sizes and the reader can then form some idea of the probable error in cases under his observation.

By reference to Fig. 3, it will be clearly seen what takes place when a tapered reamer is ground by the method in Fig. 1. The finger *F* is set at a distance *c* below the plane of centers *AB*, and, being fastened to the frame of the grinder, it does not change its position relative to the wheel. The

reamer, mounted on centers, is moved back and forth in front of the wheel with its cutting face resting on the finger. When the wheel is grinding at the small end, the cutting edge at point *D* rests on the finger a distance *c* below *AB*; but the points *E* and *H* on the same cutting edge are lower down by distances *d* and *f*, respectively. This is due to the conical form of the reamer. When the point *E* reaches the wheel and finger, it has been lifted the distance *d* and is ground also at distance *c* below plane *AB*. The same thing is true of the point *H*. It seems on the face of it that this method would produce a truly conical reamer. Hence it is that so many have fallen into the error of using it. However, by a formula which is derived below, the error is seen to be considerable in some cases while negligible in others.

The construction from which the formula is derived is shown in Fig. 4, which represents the method shown in Fig. 1. The end *D* of the finger is shown at a distance *GD* = *c* below the horizontal plane of the axes of the reamer and the spindle. The end view shows a heavy line *AHK* which represents the cutting edge actually ground by this method.

Suppose the exact diameters of the ends of the reamer are known; *A* is a point on the circumference at the small end while *K* is a corresponding point on the large end. In setting up for grinding, the centers are set over so that as the edge *AHK* passes over the finger, the wheel will grind *OA* and *OK* to the proper radii. When *A* rests on the point of the finger, *H* and *K* will be below it, as shown; but as *H* reaches the finger *A* passes above it, and *K* still remains below it. Finally when *K* reaches the finger, the whole cutting edge except point *K* will be above it, and nearer the horizontal plane of the reamer axis.

In order better to understand what takes place, the line *XY*, which represents the wheel spindle axis, is shown in the bottom view. The wheel is shown in three positions. The points *N*, *V* and *Q* are bottom views of the points ground in the three positions shown. These points will lie in a straight line, parallel to *XY*, and at distance *c* below the horizontal plane of the centers. This line *NVQ* is the line *ABD* in the end view. All points of the cutting edge *AHK* swing up into this line *ABD* to be ground. Since *NWS* is the bottom view of *AHK*, all of its points swing over into the line *NVQ*.

Let a point *W* be taken at a perpendicular distance *MT* below the end of the reamer so that $\frac{MT}{MP} = m$ which can

have any value from zero to one. When *W* is ground, it is at point *V* and we have the further geometric relation that

$$\frac{TV - MN}{PQ - MN} = \frac{MT}{MP} = m \quad (1)$$

This is taken from the triangles *NIQ* and *NI'W*. Taking now the equivalents of *TV*, *MN*, and *PQ* in the end view we have *TV* = *OF*, *MN* = *OE*, *PQ* = *OG*. By substituting these values in Equation (1) we have

$$\frac{OG - OE}{OF - OE} = m \quad (2)$$

It is from this equation that we must get the value of the radius *OH* = *OB* = *p*, which will be the actual radius ground

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by the wheel at W . Let $OA = r$, and $OK = R$, being, respectively, the radii of the small and large ends of the reamer. Then from Equation (2) OF is solved and squared as follows:

$$OF = m(OG - OE) + OE$$

$$OF^2 = [m(OG - OE) + OE]^2$$

$$p = \sqrt{(OF^2 + FB^2)}$$

$$FB^2 = c^2, OG = \sqrt{(R^2 - c^2)}, OE = \sqrt{(r^2 - c^2)}.$$

Then by substituting in (3) and simplifying we have the following value:

$$p = \sqrt{m^2[R^2 + r^2 - 2c^2 - 2\sqrt{(R^2 - c^2)(r^2 - c^2)}] - 2m[r^2 - c^2 - \sqrt{(R^2 - c^2)(r^2 - c^2)}] + r^4} \quad (4)$$

While the above equation gives the value of p actually ground, it is necessary for us to know what the value should be if the point W were on a true cone. This is shown by the

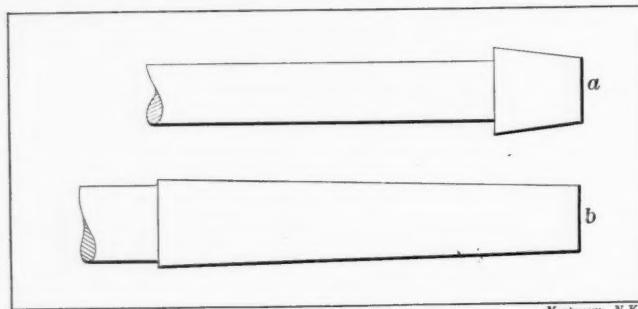


Fig. 5. Taper Reamers of Proportions given in Example 1

line ZT . The point Z is on an element of the cone and at a distance MT below the small end of the reamer. Hence we have the proportion following:

$$\frac{ZT - JM}{LP - JM} = \frac{MT}{MP} = m \quad (5)$$

ZT is our true radius which we will call p' , while $JM = r$ and $LP = R$. Then by rearrangement and substitution we have

$$p' = r + m(R - r) \quad (6)$$

The error which we are seeking will be the difference between p and p' . Hence

$$p' - p = \text{error in radius.}$$

$$2(p' - p) = \text{error in diameter.}$$

The error will vary in amount from zero at either end to a maximum near the middle of the cutting edge. Hence m may be assumed at some value such as 0.4 or 0.5.

Example 1.—Take a reamer whose diameters are 1 inch and 1.2 inch at the small and large ends, respectively. Then $R = 0.6$ and $r = 0.5$ inch. We will assume in our calculations that c is one-fifth of r . Hence $c = 0.1$ inch. Then m will be taken at different values in order to show about what it should be in this case. The errors in diameters will be as follows:

m	$2(p' - p)$
0.35	0.000152
0.40	0.000154
0.45	0.000157
0.50	0.000157

It is evident that the greatest error in this case occurs when m is about 0.5. This is so because the taper is slight compared with the diameters. This also accounts for the very small error, which is a little over one and one-half ten-thousandths inch. Fig. 5 shows two reamers *a* and *b*, which have the proportions used above. The length of the flutes does not influence the result, because it does not appear in the

$\frac{R}{r}$ formulas. The error depends on the value of the ratio $\frac{R}{r}$ and on the size of r .

Example 2.—Take the smallest or No. 1 B. & S. reamer; $r = 0.1$, $R = 0.16$, $c = 0.02$ inch; $m = 0.4$. Error in diameter is 0.000054 inch, which is very small.

Because the error in the above cases is relatively insignificant, it is not to be supposed that it is negligible in all instances. The following examples show errors of from 0.002 inch to 0.011 inch.

Example 3.— $R = 1.0$, $r = 0.5$, $c = 0.1$, $m = 0.4$.

Error in diameter is 0.00176 inch.

Example 4.— $R = 1.5$, $r = 0.5$, $c = 0.1$, $m = 0.4$.

Error in diameter is 0.00355 inch.

Example 5.—Use the same values as in Example 3, but give greater clearance by increasing the value of c to 0.15. Then $R = 1.0$, $r = 0.5$, $c = 0.15$, $m = 0.4$.

Error in diameter is 0.00408 inch, *i.e.*, more than twice as great as the error in Example 3. This shows how great an effect the amount of clearance has on the error.

Now assume some sizes that would be typical of milling cutters.

Example 6.—Use a value of c that is less than one-fifth of r , say about one-seventh. $R = 3$, $r = 2$, $c = 0.3$, $m = 0.4$. Error in diameter is 0.0016 inch which is smaller than expected because of the reduced ratio of r to c .

Example 7.— $R = 4$, $r = 2$, $c = 0.4$, $m = 0.4$.

Error in diameter is 0.00704 inch, which is four times the error in Example 3. This was to be expected because the dimensions were taken four times as great.

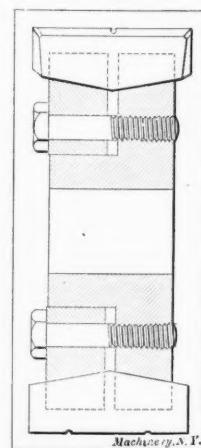
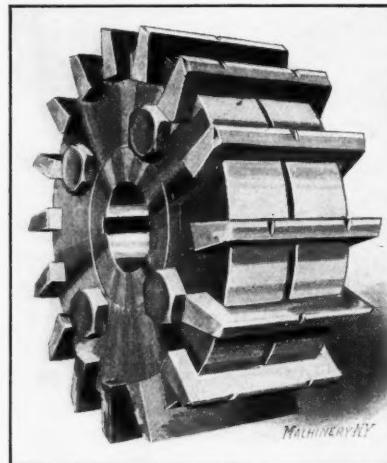
Example 8.—Take the same sizes as in Example 7 except increase the clearance by making $c = 0.5$ inch instead of 0.4.

Error in diameter is 0.0112 inch.

The errors shown above will explain many things that happen in connection with the making and the use of tapered reamers and milling cutters. Many persons have probably noticed that when grinding the clearance on a new tapered reamer or cutter the center will come up sharp before the ends do. The reason for this is now plain. When fitting an arbor into a tapered hole it seems frequently to bear hard in the middle. This may be due to the reaming of the hole in the first place by an improperly ground reamer. It is difficult even with a perfect reamer to avoid reaming the ends of the hole larger than the reamer itself. Hence any inaccuracy will tend to increase the trouble. The conclusion from the above discussion is obvious. Tapered reamers and milling cutters should be ground by the method shown in Fig. 2, *i.e.*, with the cutting edge and the point of the finger in the horizontal plane of the axis of the reamer. Then the proper amount of clearance can be obtained by lowering the reamer and finger together, or by raising the wheel.

*** MILLING CUTTER WITH INSERTED TEETH

An inserted tooth milling cutter of a design radically different from those commonly in use has been brought out by Messrs. Modes Eadon & Sons, Ltd., of President Works, Sheffield, England. The body of the cutter is made in two parts



Figs. 1 and 2. Inserted-tooth Milling Cutter of English Design

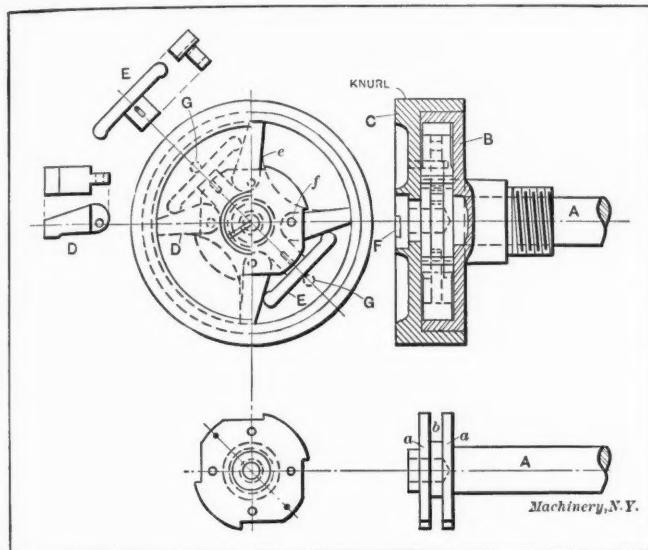
as shown in the accompanying illustrations, the two parts being drawn together either by a central nut, or, preferably, by a number of screws. The teeth are made of dove-tail section, and the bottom of the tooth is made of a V-shape as shown in the line-engraving. The body, of course, is slotted to fit this shape of the teeth. When the teeth are placed in position and the two halves of the cutter body drawn together, the teeth are forced tightly into the upper portions of the dove-tail, thus providing for an extremely firm hold of the cutter teeth. Being held by a wedge grip in two directions, it is evident that any movement whatever is impossible. It is claimed that a single tooth cannot become loose, and that breakage of one tooth does not loosen the other teeth.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

LOCKING DEVICE FOR ADJUSTING SCREWS

An automatic locking device is shown in the accompanying sketch, which is constructed as follows: Part A is the screw or shaft to be held rigid at any point that may be required. The hub parts a are turned solid on the shaft and far enough from the end to allow a bearing for the wheel C. The slot b is cut deep enough so that the lugs on pawls D and the pawl-releasing bars E have sufficient clearance to work freely. The pawls should be put in position as shown in the assembled view, and held rigidly while turning them to the inside diam-



A Device for Locking an Adjusting Screw in any Position.

eter of the friction cup B; they are then relieved at the shoulders until their face edges come back almost on a line with the center, when the friction cup is removed. This friction cup is screwed or bolted to the casting carrying the shaft; the parts are then assembled. The pawls D are held in place by pins f and are forced outward by springs e. The pawl releasing-bars are put in position as shown, and the shaft is put in place with the releasing wheel C mounted on the end and secured by a screw F adjusted to allow the wheel to work freely. The pins G of the releasing wheel are in contact with the pawl-releasing bars E. By turning the wheel either to the right or left, these pins force the releasing bars inward, bringing the pawls away from the walls of the friction cup; the shaft is then readily moved in the required direction. It will be seen that when the wheel is released the springs e will force the pawls outward against the walls of the friction cup, and any attempt to turn the shaft will meet with a stubborn resistance at these points of contact. This little wheel is thoroughly practical and it relieves one of the dread of having an adjustment altered by the jarring of a machine.

Baltimore, Md.

ROBERT O'NEAL.

MAKING PRESS FITS

Making a press fit is looked upon by a great many machinists as a very difficult job, and undoubtedly this is true in cases where the machinist has no micrometer calipers and depends entirely upon his sense of feeling. Without the micrometer, it is impossible to know just what has been allowed in difference between the diameter of the plug and hole, and, consequently, the pressure required to force in the plug cannot be even approximately ascertained. Of course in manufacturing shops where one man does all the press fitting, does it continually, and calipers with gages made by the tool-maker, with the allowance calculated for him, he cannot be expected to do other than a good job. On the other hand, in contract or repair shops it is too expensive to make gages, as the jobs vary too often; consequently, making a press fit in such shops requires considerable skill.

It is only necessary to use an inside caliper with micrometer adjustment for this work, as this tool may first be set to the exact size of the bore and then to the required number of thousandths larger than the bore. A regular pair of outside calipers may then be set to the inside caliper. I have kept a record of press fits recording the kind of metal, allowance, area of fitting, and the pressure required to force the plug in the hole. This record has proved valuable to refer to when making press fits, but the handiest and most accurate data I have found is that given in MACHINERY's Data Sheet for August, 1903. I have used this Data Sheet for some time, and find it to be so accurate that I can place absolute confidence in it; thereby removing that lump in my chest that used to settle there every time I made a press fit. If you want to do good work, buy or borrow a good inside micrometer caliper of good make, get this Data Sheet, study it until you understand it thoroughly, and you will soon be up-to-date. By tak-

ing the formula $P = \frac{AD(PF)}{2}$ and transposing it thus

$$D = \frac{A(PF)}{2P} \text{ the allowance when the number of tons pressure}$$

is known, is easily determined. In these formulas,

P = pressure required in tons,

D = difference in diameter between plug and bore,

PF = pressure factor taken from Data Sheet,

A = area of fitting in square inches.

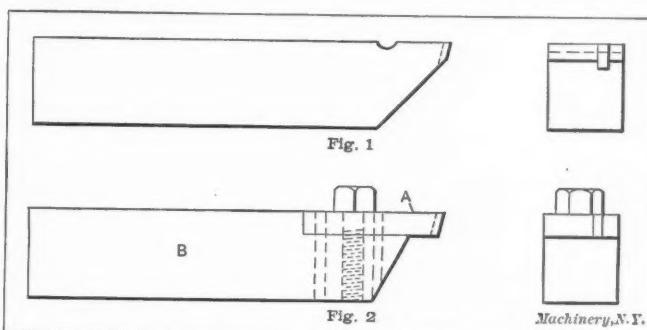
By using the last formula, and then caliper as described, one will be surprised at the accurate results obtained. A good lubricant to use when pressing the plug into a hole, consists of white lead and machine oil, just enough of the oil being added to make a paste of about twice the consistency of paint.

Augusta, Ga.

J. S. VAN PELT.

MASTER FORM TOOLS

The extensive use of circular forming tools, brought about by the introduction of the automatic screw machine, has led to more or less experimenting to obtain an inexpensive method of making the master tools with which the tool used to form the circular cutter is made. In some shops this tool is made



Master Tools for Making Circular Cutters

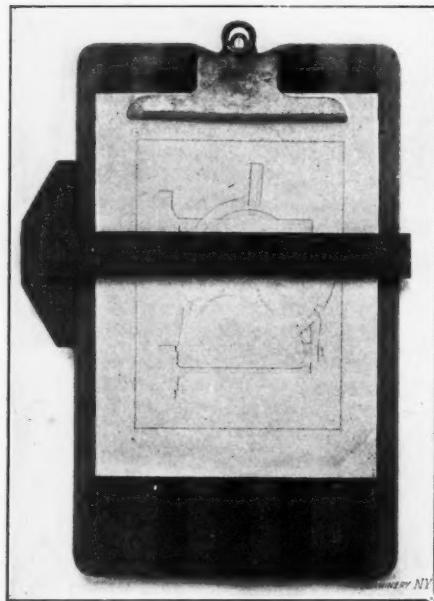
in the shape shown in Fig. 1, being a solid bar of steel. The outline is laid out on the cutting end and the tool is milled out and finished by filing. This type of tool is often annealed and recut for other forms after the completion of the forming tool. The blanks, of different widths desired, are carried in stock ready for use, and a minimum amount of labor is left for the form-tool maker, as the roughing out is all done with cheaper help. In other shops the master tool is always saved and filed away, in a cabinet, with the form tool, and when this is the case the design shown in Fig. 2 is superior because it occupies less space than Fig. 1, and it is also much easier and less costly to make. In Fig. 2, A is the tool proper which is fastened to the holder B by a hexagon head screw and two dowel pins. Both screw hole and dowel pin holes are drilled and reamed in a simple jig, so as to get the correct location from the back edge of the tool. In making these tools, much costly experimenting has led to the

adoption of "Intra" steel for the master tool, while the circular tool is made from several different brands of high-speed steel, depending on the material to be operated on and other considerations.

F. CHAS. SCRIBNER.

Greenfield, Mass.

CONVENIENT DRAWING OUTFIT



Filing Board used for Drawing

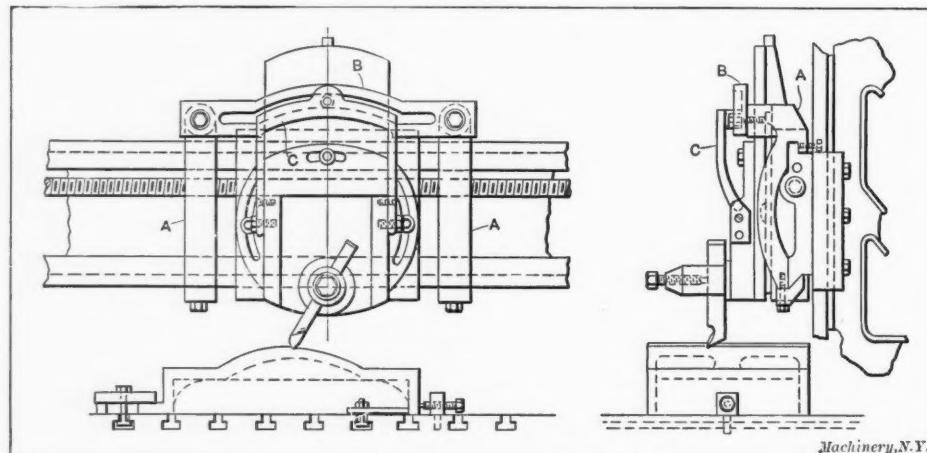
store. The drawing paper is held by the spring clip as shown.

MARTIN JOACHIMSON.

New York City.

PLANER ATTACHMENT FOR MACHINING CURVED SURFACES

An attachment for planing work of a convex or concave shape is shown in the accompanying engraving. The attachment consists of four parts all of which are of cast iron. These castings comprise the two side pieces or brackets *A*, the templet *B*, and the double-armed "leader" *C*, which is attached to the tool slide. Of course, different templets have to be used for different jobs, the shape of each being governed by the special requirements of the work in hand. The side brackets must be cast with bosses to allow the templet to clear the planer head, so that the latter can move along the rail. As shown, the brackets fit over the top guide on the rail and any slack is taken up by the set-screw shown in the end view. Separate pieces are fitted to the bottom of



Planer Attachment which automatically guides the Tool when machining Curved Surfaces

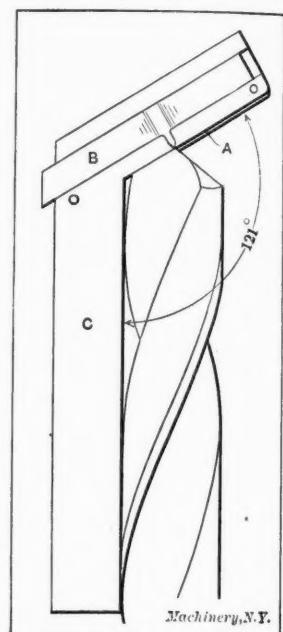
each bracket which are put in place after the fixture is put on the rail. These brackets are at all times stationary. The templet is worked out on a profiler or slotter, and it is attached to the brackets *A* by bolts. It should be machined carefully to the required shape, for, obviously, when it is made it will produce any number of pieces which will

be exact duplicates. Attached to the double-armed leader *C* is a stud upon which is mounted a loose sleeve which travels in, and fits the slot of the templet. As the head is driven along the rail the tool is automatically raised or lowered according to the formation of the guiding slot in the templet. Of course, when this attachment is in use, the screw of the slide is removed. The fixture is entirely automatic, and when it is in use the cross-feed may be put on, and the planer will take care of the work. This fixture is not new, but there are doubtless many who are not familiar with it. J. B. M.

GAGE FOR DRILL GRINDING

A gage to be used when grinding either flat or twist drills, in order to obtain the proper lip and clearance angles as well as equal lengths for the cutting edges, is shown in the accompanying line engraving. This gage is a great deal handier and more convenient to use than a protractor and scale, and, besides, it can be carried in the pocket. The surface *A* of the head forms an angle of 121 degrees with the shank *C*, which gives a lip angle to the drill of 59 degrees. Fitted to the head is a piece *B*, which slides in a dove-tailed slot and which has attached to it a pointer, as shown, which is used for measuring the lengths of the cutting edges. This is accomplished by setting the pointer as shown in the illustration, and then without moving it, turning the drill over so that the length of the other cutting edge may be measured. If the lengths of the cutting edges are unequal, the short one is, of course, ground off until the pointer coincides with the upper end of each edge. The surface *A* of the gage is beveled to an angle of 12 degrees so that the clearance angle may be tested when the drill is being ground.

Lestershire, N. Y.



Drill Gage for Testing the Lip and Clearance Angles and the Lengths of the Cutting Edges

L. B. MINGES.

MILLING FLUTES IN REAMERS WITH IRREGULAR WIDTHS AND DEPTHS

For the purpose of eliminating the chatter marks sometimes found in holes finished with reamers having equally spaced teeth, a good method is adopted by most reamer manufacturers, which is perhaps known to all reamer users, of making flutes of irregular widths and depths. Having had the opportunity to cut reamers of this type, I have tried the following method which has proved quite satisfactory.

Suppose we want to cut a reamer with 6, 8, 10, 12, or any regular number of teeth. Knowing, as we do, that a circumference contains 360 degrees, and bearing in mind that opposite teeth are to be cut to the same depth (to facilitate measuring), it will readily be understood that instead of dividing 360 degrees into irregular spaces, we divide 180 degrees into one-half as many spaces

as flutes required. Let us take for example a reamer to have 12 flutes; this gives us 180 degrees to be divided into six irregular spaces. We first divide 180 degrees by 6, obtaining 30 degrees, which would be the angular distance between the teeth for regular spacing. In order to get irregular spaces we must find six numbers that will total 180. In this case, we

have 26, 28, 30, 31, 32, and 33 degrees. The next move is to transfer the degrees to turns and holes for indexing. Nearly all milling machine dividing heads have worm-wheels of 40 teeth, making 40 turns equal 360 degrees or one revolution. This will make one turn equal 9 degrees, and by using a 27-hole circle, 3 holes will equal one degree. Going back to our irregular divisions, we first come to 26 degrees. It is not necessary to index for the first cut. The indexing for the remaining divisions is found as follows:

$$\begin{aligned} 28 \text{ degrees} &\div 9 \text{ degrees} = 3 \frac{1}{9} = 3 \text{ turns and } 3 \text{ holes} \\ 30 \text{ degrees} &\div 9 \text{ degrees} = 3 \frac{3}{9} = 3 \text{ turns and } 9 \text{ holes} \\ 31 \text{ degrees} &\div 9 \text{ degrees} = 3 \frac{4}{9} = 3 \text{ turns and } 12 \text{ holes} \\ 32 \text{ degrees} &\div 9 \text{ degrees} = 3 \frac{5}{9} = 3 \text{ turns and } 15 \text{ holes} \\ 33 \text{ degrees} &\div 9 \text{ degrees} = 3 \frac{6}{9} = 3 \text{ turns and } 18 \text{ holes} \end{aligned}$$

Having the degrees changed to turns and parts of a turn for the indexing crank, we now go ahead with the first cut, being careful not to go too deep, so that the required width of land can be obtained. It will now be seen that as the angle between the teeth changes, the depth must also be changed if the lands are to be made uniform. This depth is found more readily by practice than by figures. When large reamers are to be cut, instead of dividing 180 degrees, 90 degrees may be used, and in that case four teeth instead of two can be cut to the same depth.

JAMES FRASER.

New Haven, Conn.

REMOVING BROKEN DEEP-WELL PUMP-ROD

An A. D. Cook deep-well pump-rod separated far down in the casing, part being pulled out at the top and the remainder staying at the bottom. In order to secure the lower part, a

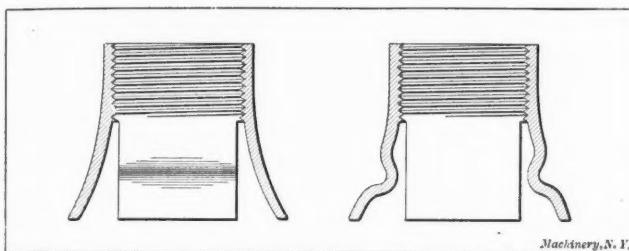


Fig. 1. Special Sleeve for Gripping the End of the Broken Rod

piece of iron pipe was split at one end into four leaves, as shown in Fig. 1, and the solid end tapped out and bushed down to fit the thread upon the pump-rod taken out. Two of these leaves were beaded to form a snap hook after all four of them had been bent out at the lower end to completely fill the well casing. These two beaded leaves were intended to form a hook smaller than the upper head of the lost pump-rod C (Fig. 2), so that when part B was lowered into the casing and forced down over the upper end of C, the leaves would spring back over the shoulder and grip the rod C, thereby enabling it to be pulled out. The device worked very

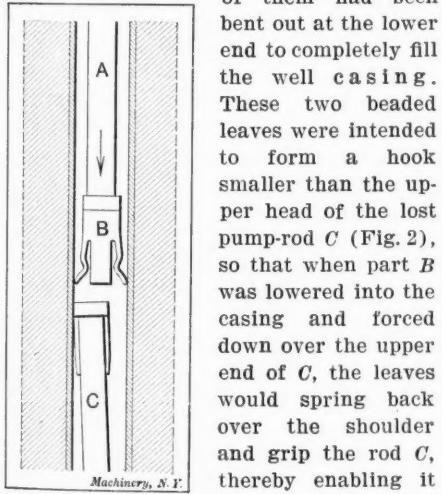


Fig. 2. Method of Removing Broken Pump-rod

satisfactorily. It was attached to the lower end of the upper section A of the broken pump-rod and lowered until C was gripped.

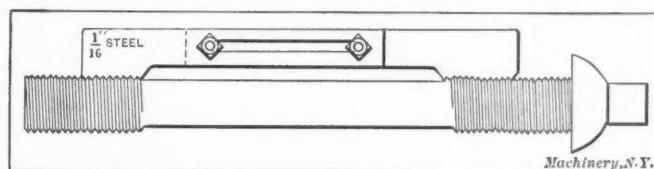
Wadsworth, Ohio.

HOWARD D. YODER.

THREAD GAGE FOR STAY-BOLTS

Radial stays are a hard thing to fit into place, according to some boilermakers, because the threads in the boiler plates and the threads on the stay-bolt will not mesh in both sheets at the same time. I knew of one case where a boilermaker spent two days putting in five stays, and these were obtained by

sorting over about one hundred stay-bolts. Schemes are tried of having the tap so made that the threads in both plates will be as on a continuous rod, and this helps a lot; in fact, it is necessary to have the holes exactly in line. But another trouble often comes from the fact that the stay-bolts are turned up in a lathe which is so worn that in a foot or two of length the pitch is a little off which changes the position of the threads so that they cross when the bolt is screwed into place in the boiler plates. It will pass through the outside sheet all right, but will not fit into the inner sheet. Now if



Machinery, N.Y.

Thread Gage applied to a Stay-bolt

this stay-bolt is lengthened a little, by hammering, so that the threads are moved a little ahead until they will exactly fit into the threads of both sheets, everything works smoothly.

The illustration shows an adjustable gage that can be used in spacing these threads. This gage can be set by the tap that was used in making the threads in the plates, or it can even be placed in the holes and set to the actual threads in the sheets. Then the bolts can be drawn out with a hammer to fit the gage, and a lot of hard work will be eliminated.

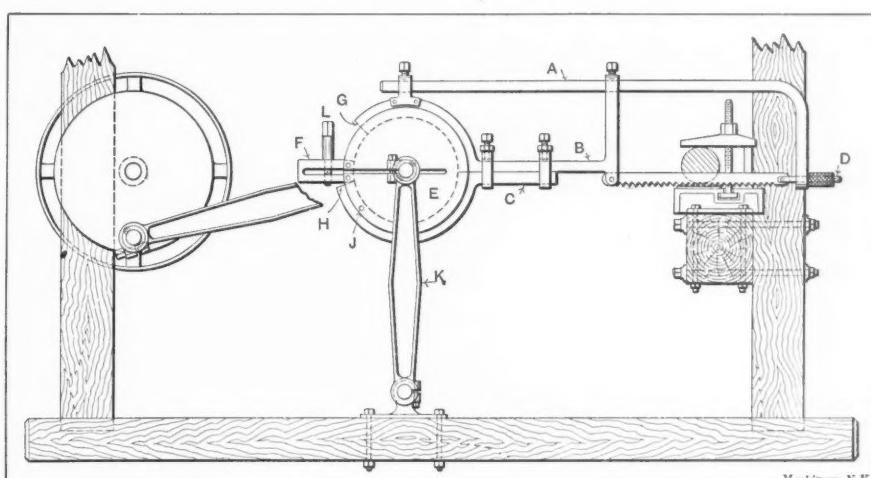
Two Harbors, Minn.

A. G. JOHNSON.

MULTIPLE POWER-DRIVEN HACK-SAW

Old, rejected street car axles were being cut into short lengths to be used for drop-forging stock, and other purposes for which this steel is suitable, but the work of sawing them on a single reciprocating saw proved too slow. A gang saw, a view of which is shown in the accompanying engraving, was built, which will cut simultaneously the whole length of an axle into any number of pieces required. The construction of the saw is simple, yet it is rigid, and will stand up under very heavy sawing.

The saw frame is composed of three pieces, A, B and C. The first is a machine steel bar $1\frac{1}{4}$ inch in diameter, the end of which is enlarged to receive an adjusting screw D. The two halves, B and C of the remainder of the frame are hand-forged from machine steel stock $1\frac{1}{2}$ inch wide and $\frac{1}{2}$ inch



Machinery, N.Y.

Elevation of a Multiple Hack-saw for Sawing Stock into a Number of Lengths, simultaneously

thick. The vertical part of B is slotted at the lower end to receive the saw, and the upper end is enlarged to provide for a hole through which passes bar A. The circular ends of B and C fit into a groove which is turned in the circumference of the cast-iron disk E 10 inches in diameter. To allow clamping this disk in any position on the shaft, a slot is milled part-way through it as shown, and also in the clamping block F, which is attached by pins, to the disk on each side of the slot. It will be noted that the end of the saw frame is not a complete circle, as it terminates at G and H. This serves two purposes: After the saw has finished its cut, the end H

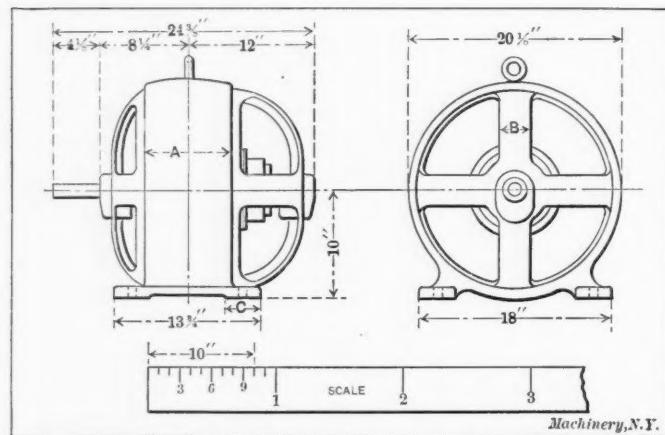
prevents it from cutting into the chucking table, by coming in contact with stop *F*, while the space between end *G* and the stop permits lifting the saw to take in any stock within the capacity of the machine. When it is desired to put one or more saws out of service, the frame is raised until the end *H* drops down past the hole *J* through which a stop-pin is inserted, thus securing the frame in an elevated position. The shaft upon which the disks are mounted, is turned down at each end to receive the vertical supporting rods *K* and also the connecting-rods. The latter are connected to the two crank disks mounted on either end of the driving shaft, which runs in bearings attached to wooden uprights. At the opposite end of the frame there are other uprights across which is secured a timber to which is attached a cast-iron plate with a T-slot which permits strapping down the stock at any place along the table. Any of the saw frames can be removed from their disk in five minutes, or replaced in the same time, and pieces of any length may be cut by simply shifting the disks to the proper position on the shaft. A key in the shaft prevents the disks from turning, and when they are properly located they are clamped by the screw *L*.

In forging the circular parts of the frame they are first formed as near the required shape as possible. After machining the joints between the two halves they are held together by the clamps shown, and the circular ends are tested on a surface plate, to see that the sides are flat, and that the vertical part of *B* is in a plane parallel with them. These ends can be faced on a disk grinder; if available, a double disk grinder is preferable. Just enough stock is removed to give a fair amount of trued surface. If no other means is at hand the inside of the strap can be machined in the drill press. By fitting the groove in the disk *E* to the strap, the latter may be ground without reference to any particular width. With a machine of this type it is possible to saw a number of pieces in about the same time as required for one; and obviously, the machine may be designed for any desired number of saws.

M. E. DAWSON.

A KINK FOR DRAFTSMEN

Very often a draftsman in laying out work, finds that he has to refer to outline drawings in catalogues where not enough dimensions are given to make a drawing from and have it to any kind of scale.



Catalogue Drawing and Scale for Measuring Details

When a drawing of this kind is to be made, as for example a drawing of the motor shown in the engraving, the dimensions of which are insufficient to make a drawing from, take a piece of paper with a straight-edge and mark off a distance, say from the base to the center of the shaft which represents, in this case, 10 inches. Then divide this space into ten equal parts and carry it on two parts more which represents one foot on the catalogue engraving. Each part of this

space represents one inch, and each division may be subdivided as required. The scale may be made any length by stepping off spaces equal to one foot, as shown in the engraving. By using such a scale, the dimensions of *A*, *B*, *C*, etc., may be easily found.

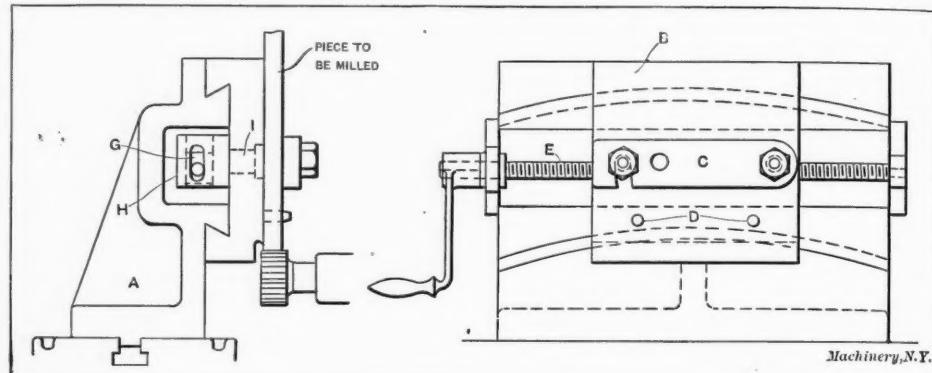
This is a very simple method and one which I find helps a great deal at times. A new scale has to be made for each different engraving, the proper proportions being obtained from some one of the dimensions given.

New Haven, Conn.

J. H. SCHULTHEISS.

MILLING ATTACHMENT FOR MACHINING A CURVE OF LARGE RADIUS

Some time ago we had a large quantity of parts that had a finished surface on a radius of about five feet, and this surface had to be an exact distance from two holes in the piece. The radius was far too large for any lathe we had available, but the length of the surface to be finished was only a few



Milling Attachment for Machining a Curve of Large Radius

inches, so the device shown in the accompanying engraving was made. An angle casting *A* was made with a dovetail slide of suitable radius, to which a sliding block *B* was fitted. A feed-screw *E* engaged with a nut *G* attached to the back of *B*. To allow for the variations in height and angle as *B* moved across on the curved slide, the nut *G* could slide up and down in a slot in holder *H*, and *H* could swivel on its axle *I*. Two pins were put in block *B* in the proper position to take the holes in the piece to be milled, and a clamp-bar *C* arranged to hold the work in place. The attachment was put on a milling machine and the table adjusted vertically until the cutter was at the proper height. It worked satisfactorily, and we were able to make good time on what had been a troublesome job.

W. ALTON.

HOW WE GOT ELECTRIC LIGHTS

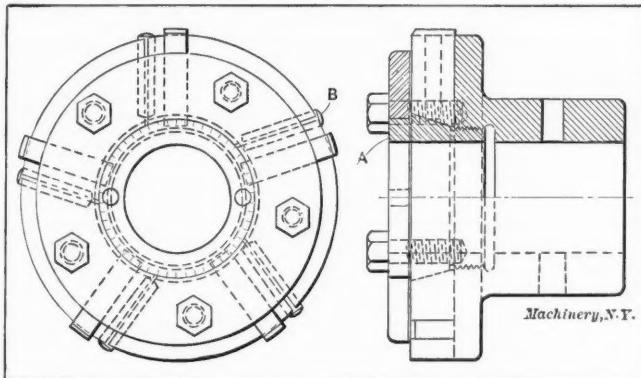
The shop where I learned the trade was a small one, and although the place was turning out a very good class of work and considerable of it, the "boss" was rather inclined to be a bit slow in putting in improvements for the benefit of the workmen. One of the improvements needed was electric lights, and many were the cuss-words which were fired at the measly old gas jets which were always in the wrong place and never gave sufficient light. One dark, dismal day one of the boys was working at the bench, and he had the gas jet down near the vise; he felt a warm sensation around the top of his head and when he put his hand up to find out what the trouble was he found that his cap and a good share of his "thatch" had gone up in smoke. Of course immediately there was added to the already pungent smell in the air, a distinctly sulphurous strata, which brought the boss post-haste to find out the cause of it all, and when Jack had finished telling of his misfortune and also consigned all such things as gas jets and behind-the-times employers to regions where we have reason to believe there is no need of gas, the boss said, "Well, Jack, that is too bad; those old gas jets are sort of a nuisance and don't give very good light anyway—I think that I'll have to get the electricity put in." Jack told him that he had just about the same sort of idea about it himself, and furthermore, that it had better be done P. D. Q. or there wouldn't be many of the boys working there.

Well, time went on into days, weeks, and months, and still we had no electricity, when one day another of the boys, Eli by name, came over to my lathe and said "Say, George, just keep a weather eye on the shipper handle of my machine. I am going over on the other side of the shop and there is going to be something doing around here in a few minutes. If things get too fierce, why stop them, but don't do it before the "old man" sees it, if you can help." I looked over to Eli's lathe and saw that he had carefully placed the gas jet so that the flame was just under the shipper handle, and in a couple of minutes the handle began to smoke and finally a bit of flame started creeping up it; just about when the flame was up to the ceiling and I was thinking it time to stop it, the "old man" came tearing down the line, jumped up on the lathe and swiped his hands down the handle and put out the fire. Of course Eli showed up on the scene about then and innocently wanted to know what the trouble was. He told the boss that he thought he had that bloody gas far enough away so that there was no danger of the handle catching fire, but it had always been a mystery to him that such things did not occur oftener. The old man did not say much except that we ought to be more careful, but I guess it started something going in his "think tank," for when, a few days later, another of the boys working at that same lathe accidentally (?) allowed the same thing to happen and the fire had even started in on the ceiling, the boss said: "Well, boys, this won't happen again—I've ordered the electricity put in this week." And sure enough, a couple of days later the men were down there wiring the shop, and the day of gas was over in that place.

M. A. CHENIST.

AN ADJUSTABLE REAMER

The reamer shown in the accompanying engraving differs in construction in some respects from any that the writer has ever seen, and it is such a good tool that it seemed worth



Reamer with Graduated Adjustment

while offering a description of it for publication. The means of adjustment is clearly shown in the sectioned part of the elevation. The cutters are beveled to fit the taper of the sleeve *A* at their inner ends, and are forced out by the inward movement of this sleeve, which is threaded 12 threads per inch. The taper part is turned to an angle of 16 degrees 40 minutes with the axis, and the end of the sleeve has 50 graduations, as shown in the end view, which makes each graduation equal 0.001 inch increase in diameter across the cutters. A spanner wrench is used to turn the sleeves. The cutters are brought to a snug fit in the sockets by means of tapered pins *B*, which are driven into split holes in the cutter head. The reamer chosen for this description is used for reaming 7½-inch holes.

C. W. HEBERT.

Nashua, N. H.

PROVISION FOR THE ESCAPE OF AIR IN PLUG GAGES

While reading an article in the September number of *MACHINERY* about plug and ring gages, I noticed that the importance of lightness was especially treated; this is indeed very important. Another important feature in connection with gage construction, which applies only to plug gages, is the provision for the escape of air when such gages are to be used in blind holes or those having closed ends. Of

course, in most cases where plugs are used such provision is not necessary, as the hole to be tested passes through the work, and therefore gives the air plenty of chance to escape; but once in awhile a hole has to be tested which is closed at one end. In this case the solid plug is rendered absolutely useless, and inside micrometers or calipers have to be used, as it is almost impossible to insert the plug before the hole is about 0.001 inch or more too large. This is because the air cannot escape, and I have been wondering why makers of plugs do not put a hole through the center, as shown in Fig. 1, so that the air could pass through it. It need not be large, but should, of course, increase in size with the size of the plug.

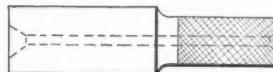


Fig. 1



Machinery, N.Y.

Figs. 1 and 2. Plug Gage with Hole for the Escape of Air, and Form for Large Gages

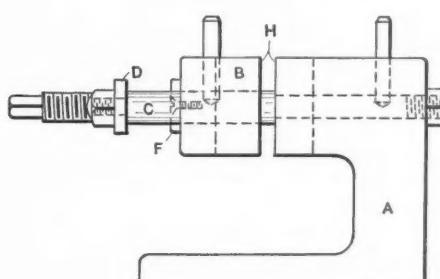
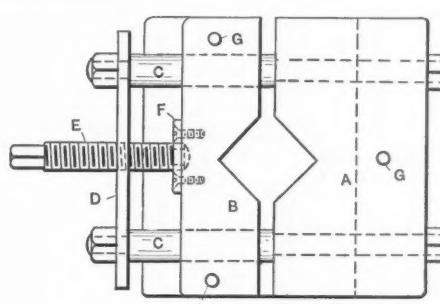
Fig. 2 shows a good way of making large plug gages. They may be made in this style for sizes from one inch and up. Gages made in this way are light, which, as stated, is an important feature, and besides, it is possible to tell with this form of gage if a hole is round or not, which may be impossible with a solid one. It is good practice to make one side of the gage with about 0.005 inch taper, especially when it is used for grinding, as it gives the user a chance to tell when he is near to the gage size. After a little practice, one will know just how much to take off by observing how far the taper part goes in the hole.

A. NIELSEN.

Cleveland, Ohio.

DRILL PRESS CHUCK FOR ROUND OR FLAT STOCK

A simple chuck for the drill press is shown in the accompanying engraving. It is intended for holding round and square stock that is to be drilled, reamed or countersunk, and also for flat plates which are either round or irregular in shape. The round stock is held in the V's and the flat stock between the pins *G*. Bar stock may be clamped between the jaws at *H*. The cast-iron base *A* is machined on the bottom and top, as are the faces *H* and the V's. The part *B* is also



Drill Press Chuck that will hold Round or Square Stock or Flat Plates of Irregular Contour

of cast iron and it is a sliding fit on the shoulder bolts *C*. Bolted across the ends of these bolts is a machine steel piece *D*, $\frac{5}{8}$ inch by $2\frac{1}{4}$ inches, having a 1-inch drilled and tapped hole to receive the clamping screw *E*. This screw, which is 1 inch in diameter, has its outer end squared to receive a wrench. The inner end, which is reduced to $\frac{5}{8}$ inch, passes through a hole in plate *F* to which it is loosely riveted. Plate *F* is secured to the jaw with $7/16$ -inch countersunk screws. This chuck will also serve the same purpose as a vise.

MACHINIST.

QUICK-RELEASING NUT FOR JIG WORK

The application of an efficient type of quick-releasing nut to a box drill jig is shown in the engraving. By referring to the sectional view, it will be noticed that the work is centered by the nut *A* and located also by a knurled screw *B*. As there was a fairly large quantity of these pieces to drill, it was necessary to save time in every possible way. Previously a hexagon-head screw was used for clamping, but insertion and removal of the work took much longer than it should have done. The idea then occurred to me of using a bayonet lock-nut the same as is employed for cutters on facing bars. The sketch shows a hexagon nut with two pins driven in diametrically opposite to each other. These pins

Fixture for Holding Countersunk Screws

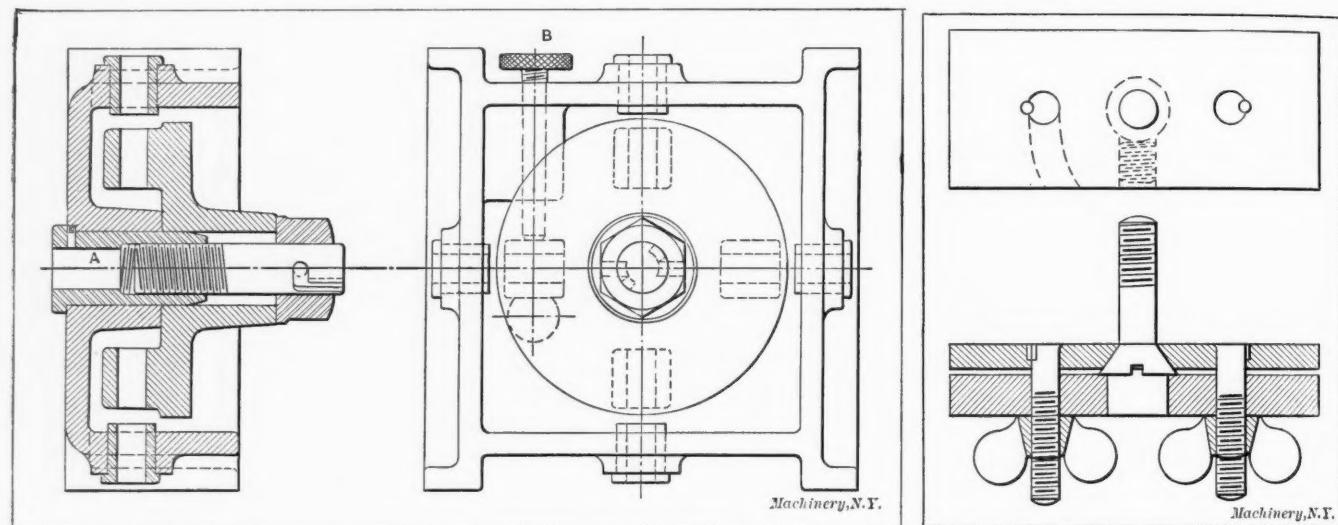
As a number of $5/16$ -inch countersunk screws had to be threaded right up to the head for a certain job, and as those in stock were only threaded about two-thirds their length, I made a fixture as shown in the illustration for holding them while the die was used to cut the extra thread. As will be understood by referring to the plan view, the work was inserted or removed from the fixture by swinging the top plate to one side. To prevent the screw from turning, a plug with a tongue fitting the slot in the screw head was inserted in the hole in the bottom plate. This plug, which is held by a set-screw, was made removable so that it could be replaced in case the tongue should twist off.

ORIGINAL.

SHEAVES FOR MANILA ROPE

Very little is being written on rope driving in technical papers, although this subject should be of almost universal interest to shop owners, etc., as the transmission of power by means of ropes has become an established fact.

In a general inspection of catalogues of manufacturers of power transmission material, it would appear that very little



Jig equipped with Quick-releasing Nut that facilitates Insertion and Removal of Work

Fixture for Holding Countersunk Screws while Extra Thread is being cut

fit into corresponding slots in the stud, and all that needs to be done to remove the work is to turn the nut half way around, when it can then be removed from the stud. This method of clamping thus saves the time which would be required for screwing a clamping screw in and out.

LORIENS.

DESIGN OF TOOL CHESTS AND CASES

As one looks over the mechanical papers of to-day he cannot help but notice the neat and compact design of tool chests that are being advertised and placed upon the market by enterprising firms. No doubt this design is the outgrowth of the call from young men who travel from one end of the country to the other partly from curiosity to see this great republic and partly from a desire to gain wide experience, but who feel that the expressage on a chest the size of a small trunk is too large a drain on the pocketbook for the extra returns in wages received. When one starts to pack one of these modern tool chests, he cannot fail to be impressed with the fact that the tool manufacturing concerns are far behind the times in the designs of tool cases for such tools as micrometers, bevel protractors, height gages, and plain squares. In many instances the cases that come with such tools occupy the lion's share of the tool chest and are many times left behind on this account. The writer would suggest that the makers of such tools place upon the market cases of a flexible type made of leather or other material that would answer this purpose and advertise the same in their catalogues or mechanical papers, and he feels sure there would be a ready demand for them.

JOHN F. WINCHESTER.

Salem, Mass.

attention is given to the details of sheave construction; however, next to the ropes, the most important detail is the construction of the sheave, as the best of ropes will be quickly put out of commission if the sheaves are not perfectly smooth as to grooves, well designed, etc.

There seem to be three different angles used for grooves, 45, 50 and 60 degrees, but the 45-degree angle appears to be the most generally adopted, and it will be found that this angle will give the best results for both the English and the American systems of rope driving. It is contended by some that 45 degrees for the English and 60 degrees for the American system is the most correct, but no sound argument has yet been made why the American groove should not be the same as the English system, or 45 degrees.

The word "split," where it is used in reference to sheaves, appears in many catalogues. A split wheel, as it is generally understood, is cast whole with cored slits; wedges are then driven in the cored slits to split the wheel, and this gives fractured joints. This method is used for belt pulleys, but should not be used on sheaves. Sheaves, if not made solid, should always be cast in two pieces, the joints planed, the bolt holes drilled, reamed and fitted with finished bolts. Fig. 1 shows a sectional view of grooves as generally found in catalogues, for the English or multiple system. As generally shown, dimension *t* remains the same, whether the sheave is for one or more ropes. Section *t* is made stronger than section *f* to avoid breaking in handling; but, for instance, take a sheave that is made for ten 2-inch ropes: Section *t* will appear to be nicely proportioned, but for a sheave with two 2-inch ropes, this section will be all out of proportion with section *f* (see Fig. 2). Of course, section *t* cannot fall below a certain

thickness, but there is also no reason for making it the same for any number of ropes.

In laying out the grooves, we will find that for sheaves having six or more ropes, a certain standard for section t will be all right, but for sheaves having less than six ropes, the dimensions given in the accompanying table will be more in accord with section f for sheaves up to 60-inch pitch diameter. Sheaves larger than 60-inch pitch diameter may have

TABLE GIVING THICKNESS FOR SECTIONS t AND f FOR SHEAVES UP TO 60-INCH PITCH DIAMETER AND FIVE ROPES OR LESS

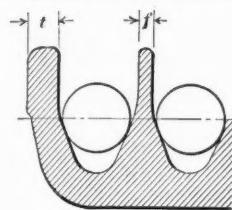
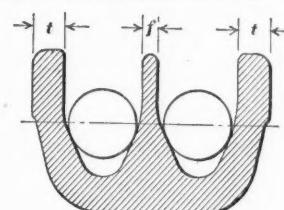


Fig. 1.



Machinery, N.Y.

Size of Rope in inches	t	f	Size of Rope in inches	t	f
$1\frac{1}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{16}$
$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{2}$
$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	2	$\frac{1}{2}$	$\frac{1}{2}$

the regular thickness for section t , as shown in Fig. 1, as they become too heavy if the dimensions given in the table are used.

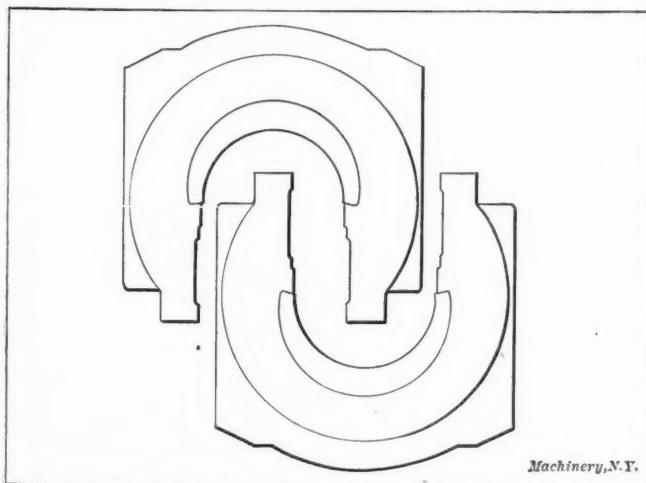
Arguments, etc., as to the advantages of rope driving, may be had from any manufacturer of Manila ropes. There is no doubt that for main drives, ropes have proved superior to belts, but for counter and machine driving, belts are still generally used.

AUGUST WACKERMANN.

Pittsburg, Pa.

CENTER REST FOR DRIVING BOXES

A machinist brought a pretty good shop kink to my notice the other day for laying out a set of driving boxes—one that saves a lot of time and trouble. In most shops when laying out a driving box the machinist fits a piece of wood in it to hold the center for his dividers. Instead of so doing, if the machinist will just slide the other box leg in between the



Simple Way of obtaining a Center Rest when Laying Out Driving Boxes

sides of the box being laid out, as shown in the illustration, he will have a good solid piece of iron, which is the same height as the box, on which to lay off the center. As the boxes are heavy, they stay in place and the two can be laid out at the same setting, using one to hold the center for the other.

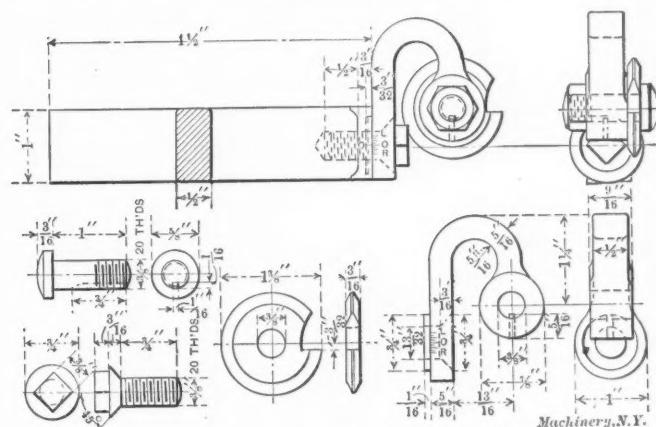
A. G. JOHNSON.

Two Harbors, Minn.

A SPRING THREADING TOOL

A tool designed for use in cutting master taps, screw gages, and other parts where accuracy is desired, is shown in the engraving. It has all the advantages of a spring tool and is

equipped with a removable cutter which can be sharpened and replaced without resetting. The principal advantage lies in the fact that the shape of the cutter may be ground to any desired degree of accuracy and no dependence need be placed on thread tools or gages bought in the market. The cutters are first rough turned, hardened, the hole lapped, and the faces ground parallel. They are then placed singly on a mandrel, and ground to the proper included angle and to a perfectly sharp edge. It will be noticed that the cutting edge



Circular Threading Tool with Spring Holder which may be adjusted for Right- or Left-hand Threads

is not radial, but to give clearance, is ground on a line 3/32 inch below, and parallel to the horizontal diameter. To secure the proper angle at this point, the center of the grinding spindle should be dropped 3/32 inch lower than the center of the cutter arbor, when grinding. If the cutter is to be made for U. S. S. or Acme threads, after grinding to a sharp edge, it is carefully measured on this diameter, the amount of flat calculated and subtracted therefrom, and the sharp edge reduced to this dimension. The engraving plainly shows the construction of the holder, by means of which the cutter can be tilted for right or left-hand threads. The lip of the cutter should be horizontal and the height of the lathe centers.

T. CAIN.

HEAVIER TOOL-POSTS FOR SHAPERS

Some of the so-called high-duty shapers are equipped with rather insignificant looking tool-posts, as shown in Fig. 1, having screws entirely too small for holding the tool. The tool-post screw for 18-inch shapers and over, where a single

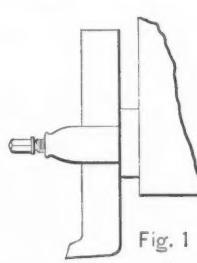


Fig. 1

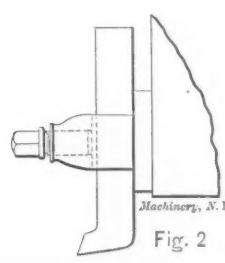


Fig. 2

Figs. 1 and 2. Light Form of Tool-post found on some Shapers, and Suggested Change

screw is used, should be at least 1 inch in diameter (instead of $\frac{5}{8}$ inch) as shown in Fig. 2. The tool-post can then be depended upon to hold the tool right where it is wanted.

Brighton, Mass.

F. RATTEK.

PROTECTING POLISHED STEEL WORK FROM RUST

Polished steel work may easily be protected from rust by the application of the following compound:

Lard	6 parts
Rosin	1 part

The two ingredients are melted together and stirred until cold. The rosin prevents the mass from becoming rancid and also acts as an air-tight film. If rubbed upon a polished steel surface, even very thinly, it effectually preserves and protects the polish. It is easily removed by gasoline or kerosene.—Brass World.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

DEEP HOLE CALIPERS

J. W. M.—I have to determine the size of a hole at the bottom of a 4-inch bore about 12 feet long. What is the best means of accurately caliper under such conditions, using either a standard measuring device or home-made contrivances?

A.—The best means depends on the character of the work, and the degree of accuracy required. The question is referred to our readers for suggestions. Descriptions of deep-hole caliper devices will be acceptable.

OILING MACHINE PARTS WHEN ASSEMBLING

G. B. D.—Should a taper pin be oiled before driving it home?

A.—A taper pin should be oiled before driving home, and in fact almost all ordinary machine parts should be lubricated before assembling whether they are pins, bolts, screws or other members. If a taper pin is oiled before being driven into place, it can be put into place with lighter blows, and will be less likely to work loose than if put in dry.

SETTING A THREAD TOOL FOR THREADING TAPER TAPS

A. B. C.—Should a thread tool be set square with the tailstock spindle or square with the surface of the taper when cutting the thread of a taper tap, assuming the work is done in a lathe provided with a taper turning attachment?

A.—The tool should be set square with the tailstock when threading a taper tap in a lathe provided with a taper attachment. The rule is to set the tool square with the center line of the tap. If the threading is done with the tailstock set over, the tool may be set square with the surface of a straight arbor of the same length of the tap, held between the centers.

TO CALCULATE THE WEIGHT OF HEXAGON BAR STOCK

G. V.—Please give a rule for calculating the weight of hexagon bar stock.

A.—Square the thickness of the stock across the flats and multiply by 0.866, and the area thus obtained by the length, to obtain the volume. The volume, in cubic inches, multiplied by the weight of a cubic inch of the material is the weight. Example: Suppose that the weight of a steel hexagon bar 2 inches across flats and 12 inches long is required: $0.866 \times 2^2 \times 12 = 41.568$, which multiplied by 0.283 pound, the weight of one cubic inch of steel equals 11.76, the weight of the bar, in pounds.

WARPING OF PUNCHED COLD-ROLLED PLATE

F. G. S.—We make a number of 1/16 inch thick cold-rolled 10- by 14-inch sheet steel plates with about sixty 1-inch holes, punched or drilled. We have tried both drilling and punching but the plates have sprung and buckled to such an extent as to make their use impossible. We have tried rolling, peening, heating and laying between heavy cold plates, but all to no avail. Can you suggest a remedy for our trouble?

A.—The difficulty is one that you probably cannot overcome with the material used unless it is annealed before drilling or punching. Cold-rolled stock is in a state of stress due to the cold finishing process. The surface is in a state of compression and the interior in a state of tension. A cold-rolled bar or plate remains straight so long as the interior and exterior forces are balanced as they were when leaving the rolls, but if metal is removed from the surface a change of shape immediately results. This will be observed in turning cold-rolled shafting or cutting long keyways in same. When you punch or drill holes in the plate, the interior and exterior stresses readjust themselves with the resulting change in shape noted. You must carefully anneal the plate before punching or drilling, or use some other material.

PROBLEM IN METAL SPINNING

R. L. C.—I have to do the job of metal spinning, shown in Fig. 1, and am doubtful as to the best method to follow in spinning this shape. The shell is to be 20 inches diameter,

6 inches deep, and 0.060 inch thick. The metal to be used is zinc.

A.—This is an interesting metal spinning job, and not a particularly difficult one. The shell can be best spun with the aid of two spinning forms, such as are illustrated in Figs. 2 and 3. These forms should be made of kiln-dried maple if there are comparatively few shells to be spun. If there are many, the form should be made of cast iron. Fig. 2 shows the first form to be used, which conforms to the outside of the shell as far as the centers of the spherical ring. Beyond these points, the form is straight. The blank to be spun is placed as indicated by the dotted lines, and follower No. 1 is used to hold the work against the form. The chief trouble

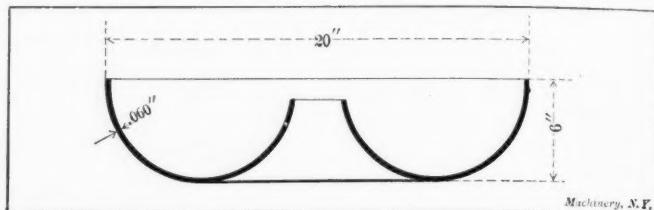


Fig. 1.

will be met in properly starting the shell, because of the small follower that must be employed. However, follower No. 2 may be substituted after working the metal back against the form a few inches, and as this gives a better grip on the shell, there will be no further danger of slipping. After spinning the zinc shell to the shape of the first form (Fig. 2) it will probably have to be annealed, but this can only be determined by trial. In annealing zinc, the flame should not be allowed to touch the metal. The half completed shell is then put on form No. 2 shown in Fig. 3. It is an easy matter to spin the metal around to complete the arc. The dotted line shows the position of the shell before starting the last part of the spinning. Of course, it will be understood that the shell must be trimmed several times during the spinning, and if the trimming is frequently done, a well-shaped shell should

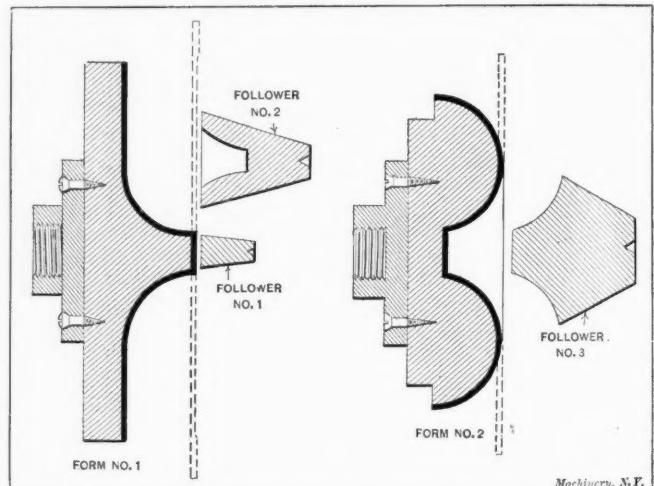


Fig. 2

Fig. 3

result. For spinning on form No. 2, follower No. 3 must be used. Either beeswax or soap should be frequently rubbed over the work while spinning. If it is necessary to cut out the center, it can be done before removing the shell from the last form by simply removing the follower and using a diamond point tool, or in large product work the swivel cutter will work well. The shell will cling to the form without the follower. The spinning speed should be from 800 to 1,000 R. P. M.

* * *

Considerable attention is given by the German technical institutions to the science of aeronautics. A bill has been introduced in the Diet of Würtemburg, asking for \$2,250 yearly for a chair in aeronautics at the Stuttgart Technical University. The government also announced that a sum of \$12,000 has been offered privately for the purpose of establishing a laboratory for aeronautics in connection with this chair.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BECKER FRICTION FEED VERTICAL MILLING MACHINE

An interesting type of vertical milling machine, embodying some radically new features, has recently been brought out by the Becker Milling Machine Co., Hyde Park, Boston, Mass. This machine will be built in four sizes, known as Models

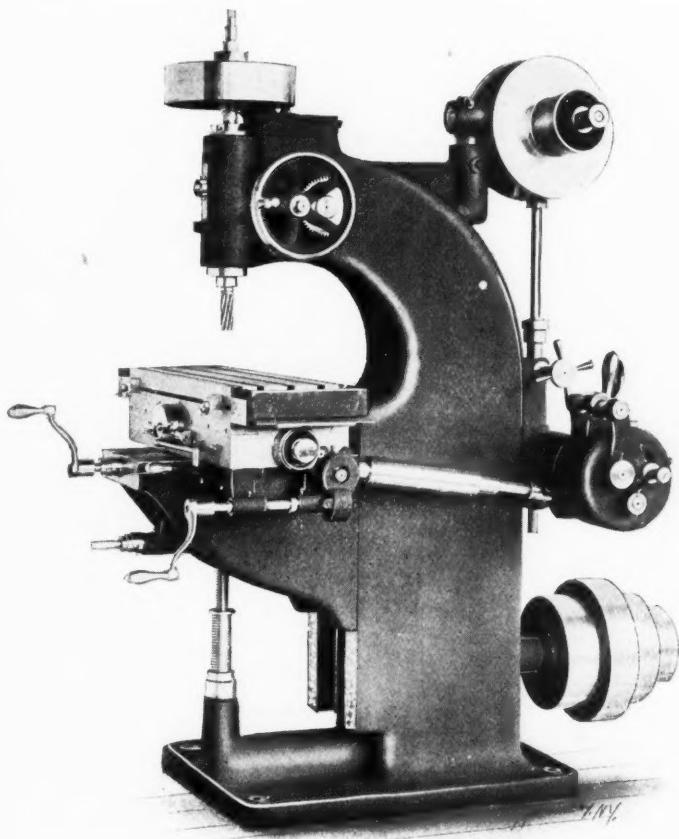


Fig. 1. Side View of Friction Feed Vertical Milling Machine, built by Becker Milling Machine Co., Hyde Park, Mass.

A, B, C and D, respectively. The accompanying half-tone illustrations show the model A machine, and the description applies in particular to this size; but all the sizes to be built embody the same features, with slight modifications in such mechanisms as the back-gearing, gear boxes, etc., which, of course, on the different sizes are made to suit the requirements for, and capacity of, each machine. Fig. 1 shows a side view of the machine and Fig. 2 a rear view, exhibiting some of the important features of the feed mechanism.

Main Spindle Drive

The main drive of the machine may be either by means of a three-step cone pulley as shown in Fig. 1, or by a constant speed single pulley drive, the power being obtained directly from an electric motor or from a pulley on the line shaft. When the single pulley drive is employed, a gear box of simple design and similar in principle to the feed gear box, which will be described later, is made use of in order to obtain the required speed variations on the driving pulley of the machine, which is belted directly to the pulley on the vertical spindle. This gear box provides for five speed changes. The machine shown is not provided with back-gearing, but if required, back-gearing arranged practically on the same principle as that of a lathe, and enclosed in a very compact gear box placed immediately beneath the pulley on the vertical spindle, is provided. The back-gearing for the model A machine is of the regular type, and for the larger sizes, of the double type, so that by means of the back-gearing and a gear box on the main driving shaft, 10 speeds on the model A machine and 15 speeds on the larger sizes may be

obtained. Five of these speeds are obtained without the back-gearing, using open belt drive.

As is clear from the illustrations, Figs. 1 and 2, the 3-inch belt from the driving pulley at the bottom of the column passes over two idler pulleys. These pulleys, as is seen in Figs. 2 and 3, are mounted on the hubs of large friction disks that operate the feed mechanism which will be described later. The spindle speeds obtainable by the gear box when the constant speed pulleys run at 405 revolutions per minute—the speed recommended by the makers—are 80, 120, 180, 270 and 405 revolutions per minute. If it be desired to obtain higher speeds than these, a two-step cone pulley may be provided on the machine, and two pulleys of the required size placed on the line shafting. By this simple means another five speeds may be obtained of 150, 225, 335, 505 and 760 revolutions per minute, without resorting to back-gearing.

The column is cast in one piece, so as to insure rigidity. The vertical movement of the spindle head is obtained by means of a hand-wheel on the side of the machine, as shown. The spindle is hardened at the main bearing, and finished by grinding. The bearing boxes are made of bronze, and provided with simple means of adjustment. The head is cylindrical, which insures perfect alignment, and is provided with a micrometer stop gage, placed, as indicated in Fig. 5, in the slot at the front of the column of the machine. The graduated collar of this stop gage is of large diameter, so that each gradu-

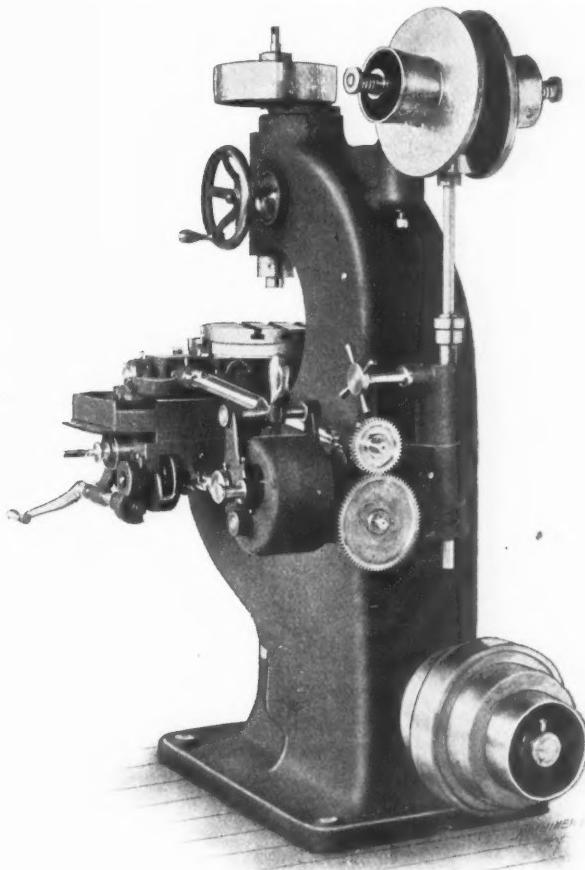


Fig. 2. Rear View of Becker Milling Machine, showing Friction Feed
tion corresponding to 0.001 inch is nearly 1/16 inch wide. This makes it possible to obtain very accurate adjustments without difficulty. At the lower end of the slot in the column a small projection or shelf is provided, on which can be placed circular gage blocks about 1 1/2 inch in diameter, carefully made to standard thickness. By means of these gage blocks it is possible to bring the head down any definite amount; for instance, if it be required to bring the head down exactly three-quarters of an inch after one cut has been made

over the work in the machine, the micrometer stop is first brought against a $\frac{3}{4}$ -inch gage block placed on the shelf or on the top of other gage blocks, and when the first milling cut has been completed on one lever, the $\frac{3}{4}$ -inch gage block is removed and the head brought down until the stop rests against either the shelf or the remaining gage blocks, and the work is completed. By different combinations of gage blocks it is possible to obtain close measurements for all movements of the head. If it is required to move the head

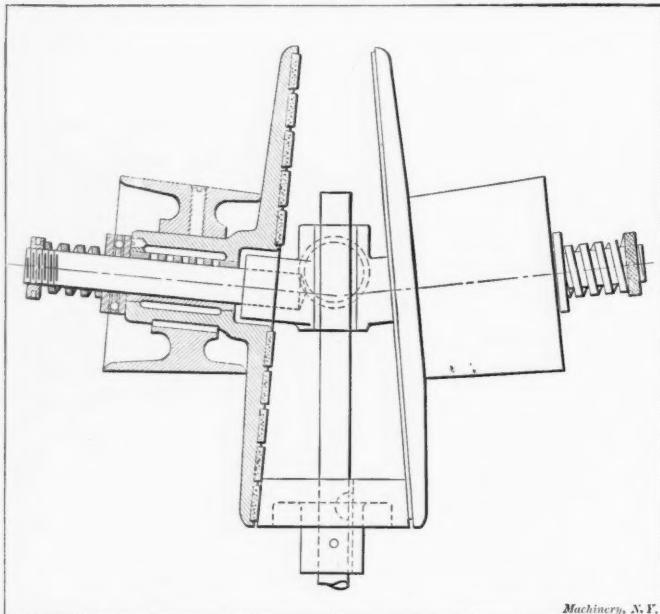


Fig. 3. Friction Feed Disks and Mounting of Idler Pulleys

only a few thousandths of an inch, the stop, of course, is brought against the gage blocks and then the graduated collar is turned the amount required, to raise or lower the head.

Friction Feed of the Machine

The distinctly novel and, without doubt, the most interesting feature of the machine is the friction feed drive. This drive may be defined as being a positive friction feed, inasmuch as the belts on the driving pulleys of the machine will slip or be thrown off their pulleys before the friction feed will cease to operate even on the heaviest cuts. This is due to the ingenious arrangement of the friction disks and the manner in which the pressure is applied to them. It will be noticed in Figs. 2 and 3 that springs are provided on the ends of the studs on which the friction disks are mounted, these springs tending to add to the pressure on the friction roller, but it has been found that by the arrangement employed these springs are unnecessary and can be removed. The pressure is furnished entirely by the driving belt passing over the idler pulleys, which are mounted on shafts placed at an angle upward and backward with the horizontal, as indicated by the position of the friction disks at the ends of the pulleys in Fig. 2. This angular arrangement produces an inward pressure of the belt on the idler pulley, which, in turn, is transmitted to the friction disks and used for obtaining the required pressure on the friction roller.

As there are two idler pulleys both placed at corresponding angles and the belt passes over both with practically the same tension, the drive is balanced, and the difficulty with friction drives usually encountered—that of providing adequate thrust bearings—is eliminated. The angle of the friction roller is 10 degrees on each side, it having been found that with the arrangement used this angle will produce the greatest pressure and the most efficient transmission of power to the feed mechanism. The idler pulleys are conical, being about one-half inch larger in diameter at the outside end than at the end abutting against the friction disks. This feature throws the belt further out on the idler pulley when running at high speed, due to the centrifugal force, and this in turn tightens the belt and increases the belt tension, at the same time increasing the pressure on the friction disks and roller. Thus, the higher the speed or the heavier the cut, the greater

the belt tension, and the more powerful the friction drive mechanism.

A line drawing, illustrating in a general way the arrangement of the idler pulleys and friction disks, is shown in Fig. 3. The idler pulleys, as shown by the sectional view, are not cast in one piece with the friction disks, but are fastened to the disks by keys and set-screws, the friction disk being provided with a long hub for this purpose; the hub is provided with ample means for lubrication.

An interesting feature, and one of extreme importance in a friction drive, is the method used for fastening the leather to the cast iron friction disks; one of the chief difficulties of friction drives in the past has been the trouble met with in the loosening of the leather from the disks. A common method employed has been to first attach one disk of leather to the cast iron disk by means of small pins or rivets, turning off the rivet heads level with the surface of the leather, and then attach another thickness of leather, by means of leather cement, to the one fastened to the cast iron disk. This means of fastening gave no trouble as long as the leather was kept free from oil, but as the leather in any friction drive, in order to transmit power efficiently, must be kept soft and pliable, and, therefore, must be oiled occasionally, the oil would dissolve the cement, and the leather disk would become loose.

In the construction used in the friction feed disks on the Becker milling machine, no cement is used between the leather and the disk, and therefore the required amount of lubrication can be supplied to the leather without any danger of interfering with the durability of the drive. The cast iron disk is provided with a number of concentric grooves of a dove-tail shape, as shown in section in Fig. 3. The leather, cut into segments, is pressed into these grooves, where it is held very firmly on account of the shape of the groove. When

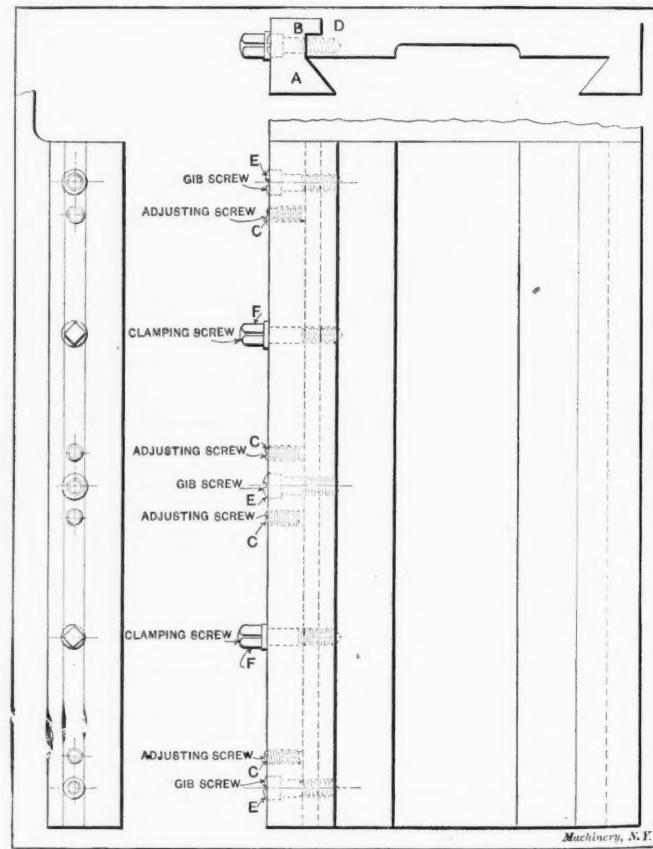


Fig. 4. Construction of Gib for Milling Machine Knee Slide

the pressure is applied to the disks against the friction roller, it is evident that the leather is still more firmly pressed into the dove-tail, so that the heavier the feed is, the firmer is the grip between the leather and the cast iron disks. The friction roller is adjusted up or down as required for different feeds by means of the small hand-wheel or spider shown in Fig. 2 at the back of the column. On the end of the shaft of this spider is a small pinion engaging with rack teeth on the sleeve of the vertical feed shaft. The power from

the vertical feed shaft is transmitted to the feed gear box shown in Figs. 1 and 2 by means of worm and worm-gear. The feed gear box is of a very simple construction. It is operated by means of the handle on the top, and by the push pin on the side of the gear box shown projecting outside of its bearing. By means of this gear box five variations in feed can be obtained without varying or changing the location of the friction roller. One of these feeds is obtained without any of the gears in the gear box proper running, but

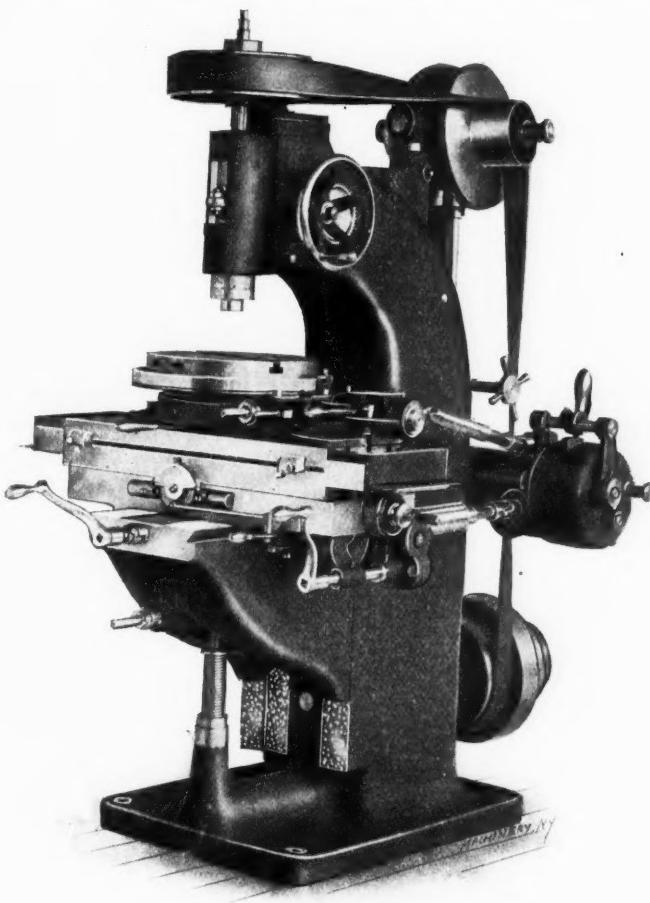


Fig. 5. Becker Milling Machine with Improved Rotary Milling Attachment

by connecting the horizontal feed shaft directly with the telescoping shaft leading to the table. In this way the loss of power incident to transmitting the motion through a great many gears is avoided, and the feed is brought to the table in as direct a manner as possible. By the combination of the friction feed disks and the gear box it is possible to obtain all feeds on the machine between 0.003 inch to 0.067 inch per revolution of the cutter. This refers to the model A machine. On the model B machine feeds can be obtained from the same minimum of 0.003 inch up to 1½ inch per revolution of the cutter.

The design of the gear box is novel, and it differs in construction from the ordinary type in important details. Instead of using a sliding gear or tumbler moving back and forth on the tumbler shaft, the whole tumbler shaft moves by means of the push pin shown. It is placed in bearings on the outside of the gear box, thus making lubrication very easy. As there are no interior bearings to oil, there is no need of a complicated lubricating arrangement with oil tubes leading to the various bearings on the inside of the gear box.

The power of the friction drive is well exhibited by the fact that the machine will take a cut in cast iron 1/16 inch deep with a feed of 1/16 inch per revolution of the spindle, with a six-inch cutter. The larger sizes, of course, will permit of proportionally heavier cuts.

Another new feature of the machine is the arrangement of the knee slide. Instead of having a knee provided with a dove-tail slide, and the dove-tail on the column of the machine, the order has been reversed, and the column of the machine is provided with a dove-tail slide, the dove-tail being on the knee. This in combination with the arrangement

shown in Fig. 4 for adjusting the dove-tail slide and binding the knee when required, makes it possible to obtain a construction without any loose gibbs. The piece A, Fig. 4, is made a very close fit in the groove in the column at B. In order to adjust the slide properly for the dove-tail on the knee, the adjusting screws C are used, which bear against the face D of the column, as shown. When the proper adjustment has been obtained it is permanently retained by tightening the gib screws or binding screws E. When it is desired to lock the knee to the column of the machine, the clamping screws F are tightened, which then spring the gib between the adjusting screws C a very small amount, enough to hold the knee rigidly in position. This method of binding insures perfect freedom from change in alignment, and is considered by the builders as a very important improvement in milling machine design. The knee is made with a double wall box construction and is thus unusually heavy and rigid.

Mechanism for Stopping and Reversing the Table

In the front of the machine in Figs. 1 and 5 is shown a new and interesting mechanism for stopping and reversing the table at the end of its travel. Stop dogs are provided as usual, operating a mechanism shown in the center of the saddle. By manipulating the two plungers on each side of the central reversing disk, it is possible to either have the machine move constantly back and forth automatically, or to have it stop at the end of its travel to the right or at the end of its travel to the left. The manipulation of the plungers can be made during any part of either the forward or the backward stroke; the machine will stop first when it comes to the end of its stroke at either the right or left, according to which one of the plungers is manipulated. The central reversing disk is provided with a spring arrangement which throws it over rapidly to either side as soon as the stop dogs have moved it over a certain amount; a pitman connects the disk with a handle which operates the clutch between the two bevel gears used for reversing the table. This makes a very simple arrangement which is exceedingly handy and useful.

The table of the machine is provided with a cover which protects the top of the saddle from chips and dirt whenever the table is moved to extreme positions either to the right or left. This cover does not telescope, but consists of a leather shield with a sheet iron hook at its end, which holds it to the end of the saddle when the end of the table passes by this point. The other end of the leather cover is rolled up in

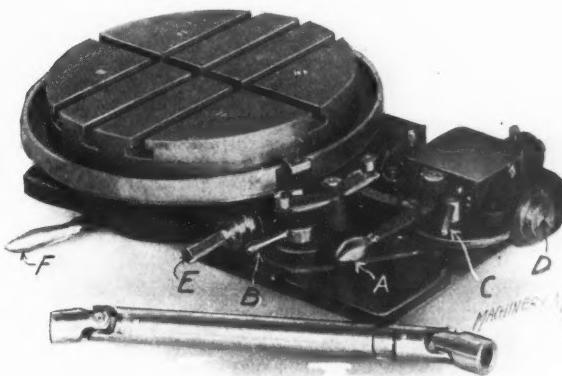


Fig. 6. Rotary Milling Attachment Removed from Table, in order to show Details

a manner similar to that of an ordinary shade. The same arrangement is used back of the table between it and the column, in order to protect the knee and the working parts contained in it from the chips when the table is moved outward.

Drive for the Rotary Milling Attachment

Another improvement which has been introduced on this milling machine relates to the drive for the rotary milling attachment shown in place on the machine in Fig. 5, and in detail in Fig. 6. In the previous types of the Becker milling machine, the rotary attachment was driven through a gear

box placed on the right-hand end of the milling machine saddle, the power being obtained through the regular telescoping shaft. In this machine, as shown very clearly in Fig. 5, the power for the rotary attachment is obtained through an independent telescoping shaft connected directly with the regular feed gear box. In Fig. 6 the attachment is shown by itself, removed from the machine; *A* is the handle which operates the clutch between the two bevel gears, by means of which the motion of the rotating table is reversed. The shaft *D* on which these two bevel gears are mounted is connected by bevel gearing with the worm-gear shaft *E*, from which the power is transmitted to the rotating table through worm and worm-gear. The motion is automatically thrown out by means of the dog shown on the rim of the rotating table, which operates the lever mechanism indicated and returns the handle *A* to a central position. The worm can be thrown out of engagement with the worm-gear by operating handle *B*, and when either thrown in or out of engagement the attachment is locked in position by the binder *C*. This arrangement has the advantage of being easily removed from the table of the machine, it being necessary only to loosen two bolts and slide it off. When required, the rotating table can be locked in position by handle *F*, and regular straight milling can be performed without removing the attachment.

General Remarks

In general, throughout the design of this machine, gears have been eliminated wherever possible. Mr. Becker, who is responsible for the design, considers that entirely too much power is lost by driving through the usual type of gear boxes, and also in obtaining feed changes through gear boxes. For this reason the drive of this machine is so arranged that even when a gear box is introduced, one set of speeds can be obtained without using the gears in the gear box; and by means of the friction feed, a wide range of feeds can also be obtained directly, without introducing the gears in the feed box. Even when the gears in the feed box are running, a maximum of two sets of gears are in engagement at a time, so that the losses due to the gearing are a minimum. The direct friction feed, when arranged as in these machines, is more positive even than a gear feed, because there is no back lash or unsteady, intermittent motion, as is likely to be the case when the gears get badly worn. As the idea of geared driving heads and speed of gear boxes has been carried rather to its extreme in some recent designs, it is all the more interesting to note the efficiency which can be obtained by returning to the older idea of using belt drives in as large a measure as possible. By means of a wide driving belt, large pulleys and high belt velocity, all the power of the regular gear-driven machine can be obtained in an open belt drive, and the present machine will do milling jobs for which the back-gears would ordinarily be used, without throwing in the back-gearing. This machine, therefore, is an interesting development in machine tool design, and will undoubtedly be received with considerable interest by the mechanical trade.

MACHINE FOR SHERARDIZING OR DRY GALVANIZING

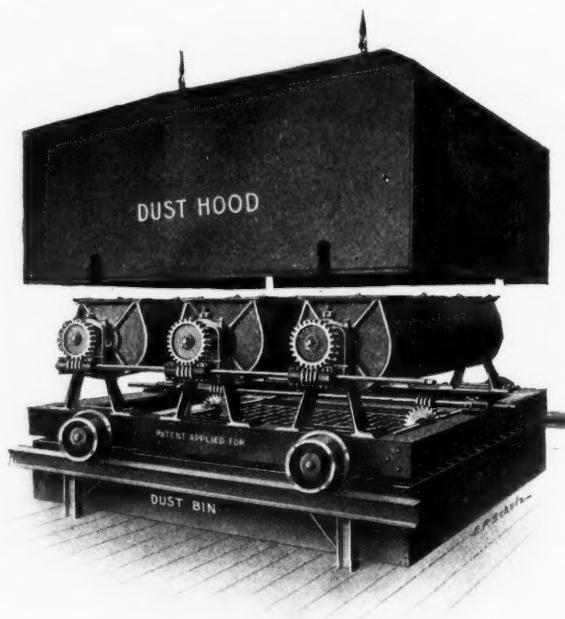
The process of galvanizing metal products by the dry or sherardizing method has been previously described in MACHINERY (see article on the subject in the August, 1908, number). It consists, in brief, in packing the articles of iron or steel to be galvanized in air-tight drums with the impalpable powder swept from the flues of zinc smelters. This powder (known to commerce as zinc dust) consists of particles of metallic zinc, about 0.00002 inch in diameter, coated with a layer of zinc oxide. When the work thus packed is heated for the proper length of time to a temperature of 800 or 900 degrees, it is given a lustrous gray coating of zinc. Apparently the zinc dust remains as it was before, the action being somewhat of a mystery. In reality, however, the dust has parted with metallic zinc and it gradually deteriorates, though it may be used over and over again for months.

The apparatus for sherardizing shown herewith is the invention of Albert F. Schroeder, and is built by the Globe Machine & Stamping Co., of Cleveland, O. This firm established the first commercial sherardizing plant in the country, de-

signing practically all its equipment for the purpose. Its experience in this work has been applied to the machine here shown, with the result of great improvement in efficiency and economy over the methods originally followed.

The most important improvement is in the provision made for rotating the drums in which the work is subject to action of the dust. Three of these drums, as shown, are mounted on a car, which can be pushed bodily into the heater. The constant agitation of the work and the dust together brings them into contact at every point of their surfaces, packing the zinc down into the interstices of chains or into the finest threads of bolts and screws. Where this rotating or tumbling is not resorted to, there are parts of the work which are liable to escape galvanizing on account of being in contact with each other, to the exclusion of the zinc.

The rotating of the drums also expedites the process by bringing new dust into contact with the work. It also assists in bringing the interior up to the same degree of heat as the



Schroeder Machine for Dry Galvanizing

oven, by continually bringing new hot dust from the walls to the cooler interior. This shortens the time required, as zinc dust is naturally a poor conductor of heat. For the same reason, the interior temperature tends to keep the same throughout the whole area, enabling the operator to control the process better than under the old conditions.

As may be seen the drums are rotated by worm gearing. The contents are shoveled into them through the opening made by removing a flat plate on top. To empty the drums, they are revolved half way round. The emptying takes place over a bin provided with a screen top, which allows the dust to fall through, leaving the work clear on top. The dust-hood shown is dropped over the machine during this emptying process, preventing its escape into the room. The dust-hood and bin are, of course, located outside the oven, from which the car is removed previous to tumbling.

The sherardizing process has been adopted by some of the largest electrical and other concerns of the country, and has been in successful use for several years in foreign countries.

WELLS POLISHING AND FINISHING LATHE

The polishing and finishing lathe shown in the accompanying half-tone illustration is built by the F. E. Wells & Son Co., Greenfield, Mass., and is designed for all kinds of light work, such as polishing, burring, etc., on pieces which can be held in a spring or collet chuck. As indicated in the illustration, the chuck is opened by a foot lever, which at the same time shifts the belt to the loose pulley and applies a friction brake for stopping the machine immediately. When the pressure on the foot lever is released, a spring shifts the

belt back again to its driving position on the tight pulley, and the chuck, at the same time, is closed. This arrangement makes it possible for the operator to have both hands free for handling the work.

The general dimensions of this machine are as follows: The length of the bed is 42 inches; the swing over the bed,



Polishing and Finishing Lathe, built by the F. E. Wells & Son Co., Greenfield, Mass.

11 inches; and the capacity of the chuck from $\frac{1}{8}$ to 2 inches. The width of the driving belt is 2 inches, and the weight of the machine complete is 325 pounds.

NO. 1 TILTED TURRET SCREW MACHINE

In the department of New Machinery and Tools in the July, 1909, number of MACHINERY, we described in some detail the design and construction of the "tilted turret" screw machine made by the Wood Turret Machine Co., of Brazil, Ind. The

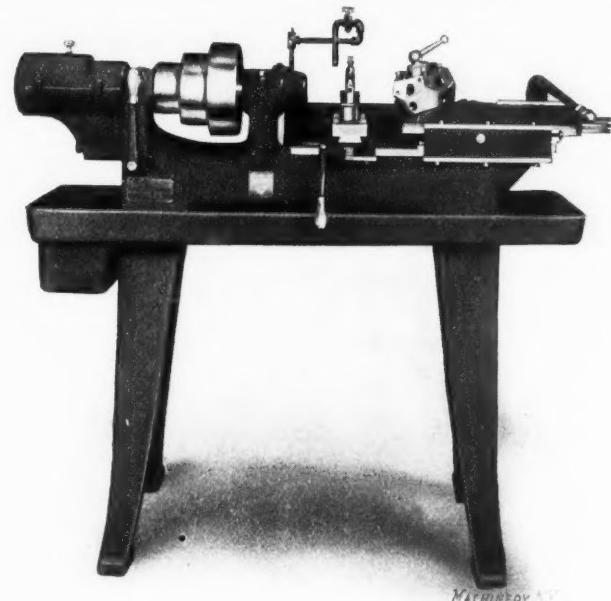


Fig. 1. No. 1 Size Tilted Turret Screw Machine

turret slide of the machine then illustrated was operated by a pilot-wheel. The accompanying illustrations show a smaller size of this machine of the same general design, but provided with a lever feed.

Fig. 2 shows this lever feed to best advantage, and illustrates as well the novel points of its construction. A rack and sector movement is used. The lever and sector form one piece, and the latter meshes with a rack secured to the turret-slide. With the usual construction on small size screw ma-

chines, the lever is pivoted to the slide, and is connected to the slide bed by a link or swiveling post. Under these conditions a changing leverage results, which requires the operator to exert more power at the start and finish of the stroke than in the middle. The arrangement shown in Fig. 2, however, permits the operator to exert the same pressure against the work at all parts of the stroke, allowing a much greater effective length of motion, so that longer cuts can be taken than on other machines of the same capacity.

The general construction of this machine is the same as with the designs previously illustrated. The tilting turret, from which the machine takes its name, will be readily recognized. It allows the stock to pass into or directly through the turret head, the center bolt being bored to permit this. When projecting through, the stock passes out through one of the auxiliary holes in the lower half of the turret in the rear, without interfering with tools clamped in the rear position. The construction has other incidental advantages as well. The strain on the center bolt is minimized, since the angular setting of the turret applies a part of the thrust directly onto the slide, doing away with the tipping occurring with the old style high turret. Furthermore, the construction permits the use of die heads or box tools of larger diameter than on other machines of the same capacity and the same swing.

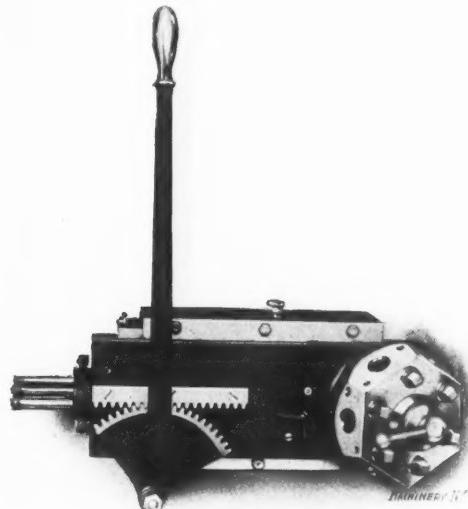


Fig. 2. Lever Feed of No. 1 Tilted Turret Screw Machine

Other features of this design that should be noted are the provision for lining the turret holes horizontally and vertically with the spindle, the provision of independent stops for each hole in the turret, and the arrangement for throwing out the indexing mechanism when only one hole in the turret is to be used. The lock pin holes are bushed so that any wear that may occur can be taken care of by rebushing the holes.

The machine here shown is the No. 1 size, having an automatic bar chuck capacity of $\frac{3}{4}$ inch. It is provided with an automatic stop feed. This tool may be seen in operation at the demonstration shops of Hill, Clarke & Co., in Boston or Chicago, or at their branch offices in New York, Philadelphia and Cleveland.

BAKER BROS. NO. 0 CYLINDER BORING MACHINE

The illustrations herewith presented show the well-known drilling machine made by Baker Bros., of Toledo, O., in a design especially adapted to automobile cylinder boring. This machine is the smallest member of a line which includes five sizes and types of single, double and four-spindle machines. This particular one is designed for boring small cylinders, being rated for diameters up to $3\frac{3}{4}$ inch and depths up to 8 inches. This is its range with maximum production, but it will easily bore much larger diameters, as it is provided with an unusually powerful spindle driving mechanism.

A distinctive feature of the machine is the provision made for employing boring bars of nearly the full diameter of the cylinder being bored. It is this feature which accounts for

the large output of which the machine is capable. The bar is driven from the spindle by a tongue and groove joint as shown. It has a bearing in a housing bracket, which is secured to the front of the machine, and carries a bronze bushing fitted to a taper seat. This provides adjustment for the bearing of the hardened boring bar, which is thus held so closely that there is no danger of its following the cored hole.

It is customary to set these machines up in gangs of three or four units. Where the cylinders are reamed, they are roughed under the first spindle, straightened under the second and reamed under the third. When two cuts only are taken before grinding, the cylinders are roughed in the first and third spindles and straightened in the second and fourth. The method of handling the work is such that the cylinders may progress from one spindle to the next without interruption for rough boring, straightening, boring and reaming. The design is such as to adapt the machine to the boring of single cylinders, twin cylinders, or four cylinders "cast in block." The engravings show the machine with a fixture for holding an unusual type of open end cylinder.

In regard to the general design of the machine, it may be said that it is adapted to high speeds and feeds. All shafts are ground, and all bearings are bronze bushed. Most of the gears are of steel, hardened where necessary, and run in a bath of oil. The machine swings 12 inches from the center of the spindle to the frame. It has 8 quick change geared spindle speeds, and 12 changes of geared feeds. A single belt-drive is provided, the design of the machine being such that it may be belted directly to the line-shaft, allowing a number of them to be placed side by side to form gangs of any required number of units. The weight of the machine is 3,500 pounds and the floor space occupied is 3 feet, 6 inches square.

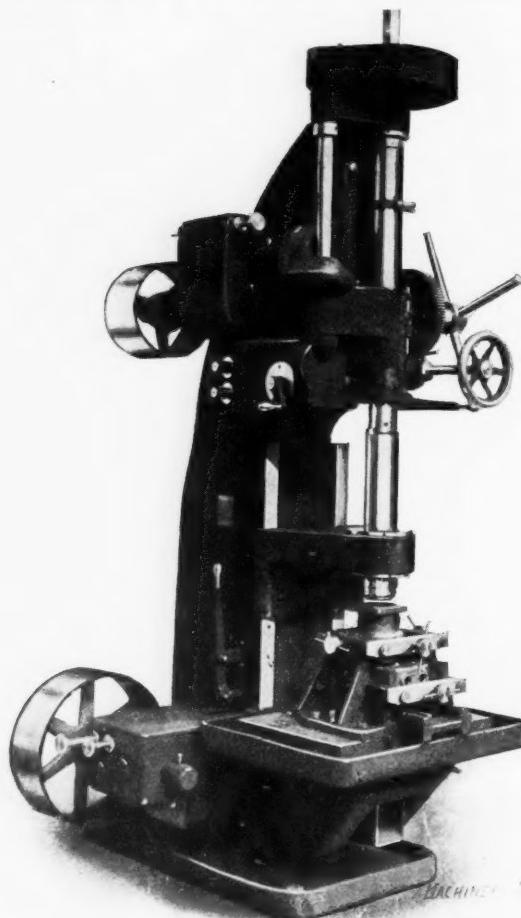


Fig. 1. Baker Automobile Cylinder Boring Machine

The makers of this tool have kept in close touch with automobile work from the beginning, and are prepared both to design and build tools and fixtures for use in machines of this type, or, if preferred, they will give their customers the benefit of their experience in this line in the way of sugges-

tions. When required, special attachments for boring, facing and tapping the seats of automobile cylinders will be furnished. With these attachments, either two or four tools can

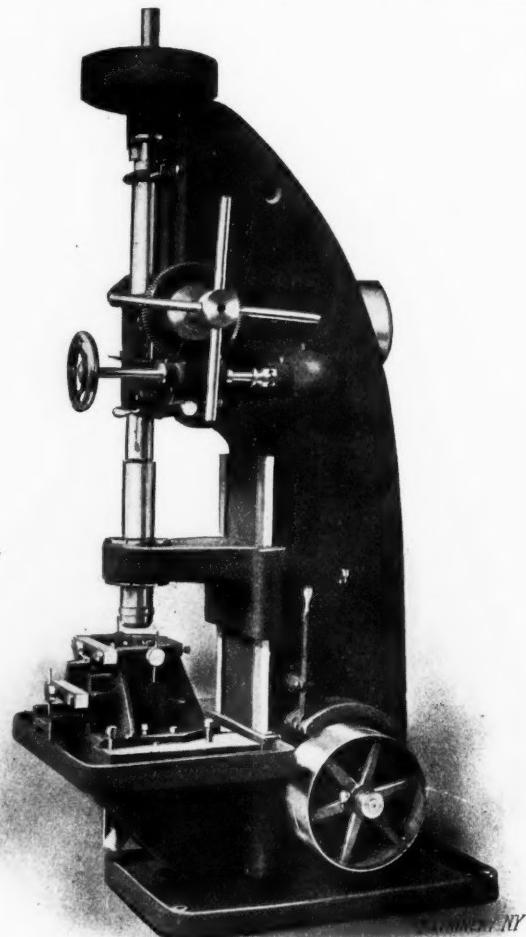
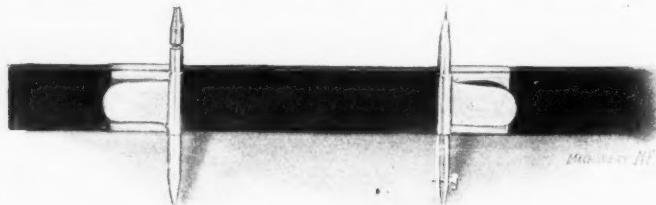


Fig. 2. Side View, showing Single Pulley Drive, Boring Bar Support, etc. be carried by each spindle, thus materially increasing the capacity of the machine.

P. S. ANROS CO.'S BEAM COMPASS

Every draftsman has experienced the need of a light, convenient beam compass that can be quickly and accurately adjusted and still be rigid enough to insure good work. The P. S. Anros Co. of North Tonawanda, N. Y., have met this demand by putting on the market a very neat and convenient instrument of this kind. It is the acme of simplicity, inex-



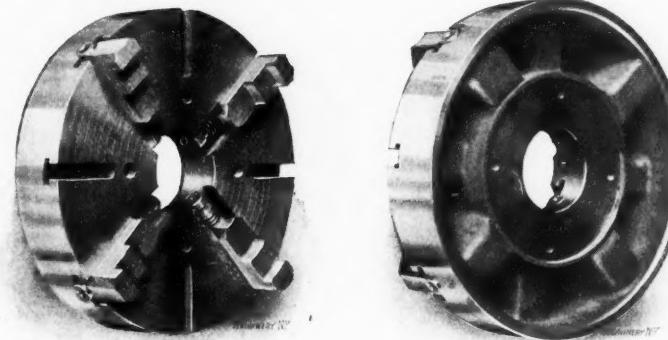
An Inexpensive but Practical Beam Compass

pensive, and at the same time a tool that is thoroughly practical. The construction is such that use is made of the opposite ends of the pen and pencil for the needle points, so that either pen or pencil is instantly available by turning the instrument over. The adjustment of the sliders, which carry the pen and pencil along the beam, is particularly smooth, making it possible to set the compass as accurately as with some of the more expensive instruments. These sliders are simply spring steel bands that fit the wooden beam closely and retain their position by friction. Both pen and pencil are easily adjusted vertically, and they, like the sliders, are held in place by friction. Undoubtedly, draftsmen in need of a beam compass will find this a very handy addition to their set of instruments. The price of the tool is one dollar.

S. E. HORTON FOUR-JAW INDEPENDENT CHUCKS

The S. E. Horton Machine Co., of Windsor Locks, Conn., has entered the chuck field with the line of four-jaw independent chucks herewith illustrated and described. This type of chuck possesses certain advantages for general work. The jaws are reversible by simply running them out and turning them end for end; the independent control of the jaws makes it possible to handle a large variety of rough forgings, castings and pieces of irregular outline; and it permits as well, the truing up of finished work to run with any desired degree of accuracy.

In addition to these general qualifications, this design has special advantages of its own, which fit it to meet the three prime requirements of a good independent chuck—namely, the requirements of strength and gripping power, durability, and workmanship. These advantages are derived largely from the improved proportions given the jaws and screws, as shown in detail in Figs. 5 and 6.



Figs. 1 and 2. Front and Rear Views of the S. E. Horton Four-Jaw Independent Chuck, 18-inch size

The strength and stiffness of the mounting provided for the jaw are shown clearly at the right of Fig. 6. A plain T-slot is cut in the face of the chuck in place of the usual tongued groove construction shown at the left of the engraving. A glance will explain the advantage of this arrangement in the matter of the resistance of the jaw to the lateral thrust (shown by the arrow) imposed on it by the driving of the work. The broad base and liberal bearing surface give, also, unusual strength and long life to the jaws and slides.

A further advantage of this form of jaw is that it permits the use of a screw of unusually large diameter ($1\frac{1}{4}$ inch for the 10-inch chuck and $1\frac{1}{2}$ inch for the 15-inch size). This screw, as shown, has a complete half bearing in the jaw, bringing the tightening strain more nearly in line with the work than the usual construction allows. There is thus less tendency for the jaws to spring away from the

work. In addition it should be noted that three bearings are provided for the screw, all of them on turned diameters, no reliance being placed on the threaded surface as a journal. This greatly increases the durability at a point where durability is very necessary. The thrust is so taken up on these bearings as to distribute the strain properly through the chuck body. The shell cannot break out at the end of the screw.

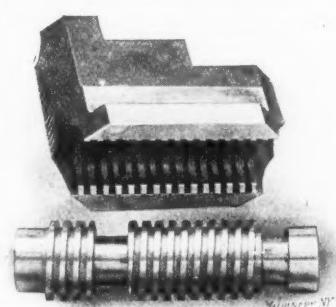


Fig. 5. The Broad Based Jaw and Large Screw
bearings as to distribute the strain properly through the chuck body. The shell cannot break out at the end of the screw.

It will be seen that the socket for the wrench is formed in stock of the full root diameter of the thread, thus giving the maximum size and strength at this important point.

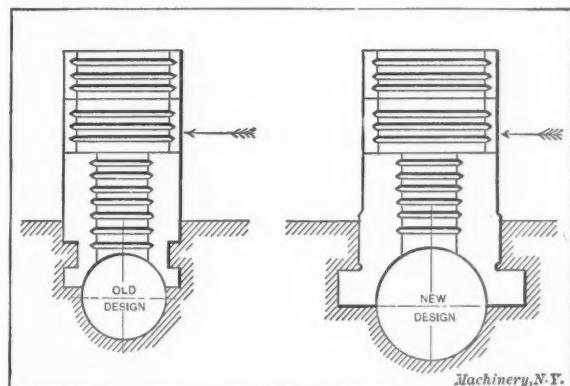
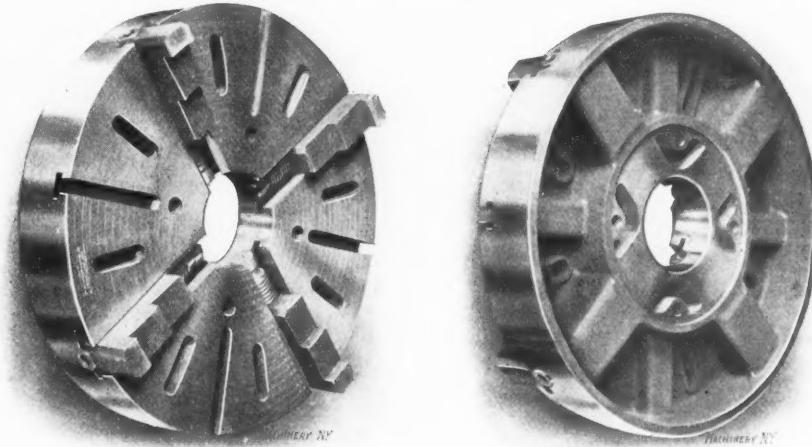


Fig. 6. Comparison of Jaws and Screws in Old and New Designs

As a result of this increase in the stiffness and durability of the jaw and screw, a much heavier clamping strain can be exerted without danger of breakage or excessive wear. For this reason, wrenches of much greater leverage than usual can be, and are, provided. The construction also permits the extension of the jaws for one-third of their length outside of the body, giving an increased capacity. This extended diameter is 11 inches for the 10-inch size, and $16\frac{1}{2}$ inches for the 15-inch.

Figs. 1 and 2 illustrate front and rear views, respectively, of the 18-inch chuck. The body, it will be seen, is of standard design, but of very heavy and rigid proportions. Chucks from 20 inches up are made in the styles shown in Figs. 3 and 4, being provided with through slots for face-plate clamping, in addition to the T-slots provided in the smaller sizes. The conveni-



Figs. 3 and 4. A Larger Size of the Horton Chuck, with Provision for Using Clamp Bolts

ence of this on large chucks is well recognized by mechanics. The hole through the body is unusually large. This feature, which is permitted by the improved design, is an advantage in holding work having a large hub; or it may be utilized, if desired, in fastening on the spindle face-plate with the hub projecting inward instead of outward as usual. This method of mounting greatly reduces the over-hang, and gives a corresponding advantage in the matter of stiffness, but the central hole of the chuck is not usually large enough to permit it. The hole through the body of the 10-inch chuck is $2\frac{3}{4}$ inches in diameter; on the 15-inch size, the diameter of the hole is 4 inches.

In relation to the matter of workmanship, a study of the illustrations will show that the construction is such that accuracy is easily secured. This line also has the advantage of being designed and made by men who have been in the business for many years, and have become specialists in this work. The regular list covers sizes from 8 to 26 inches inclusive.

HAMMOND WIRE BELT LACING TOOL

A tool of simple construction for making wire hinged joints for leather belts, is shown herewith. It is intended to take the place of the more costly machine for this work. Besides having the advantage of cheapness, it has that of portability. These tools may be kept in the various tool-rooms of an establishment and checked out for bench work the same as drills, clamps, etc., it being convenient to hold them in an ordinary vise as shown in Fig. 1.

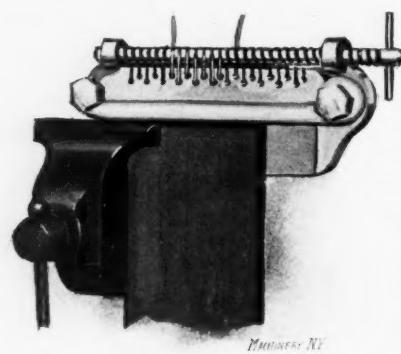


Fig. 1. An Inexpensive and Efficient Wire Belt Lacing Tool

is pushed into place between the clamps, being fastened there with its edge resting against the guide-screw. Holes are then punched through the belt with an ordinary awl, the slots cut in the clamping bar serving as a guide. Wires are then threaded through these holes and around the guide-screw, using ordinary pliers for the operation. When the belt has

The process of lacing the belt should be obvious from an inspection of the engravings. The threaded guide-rod is inserted in place and the belt (whose end has been squared)

hide pin completes the joint, when the belt is again put in motion.

This tool is made by Geo. W. Southwick Co., 35 Warren St., New York. It weighs only three pounds and is sold at a very low price. This tool may be used in a vise, as shown in Fig. 1, or it will be furnished with a stand, as shown in Fig. 2, for use in shops where vises are not employed.

DETTRICK & HARVEY NO. 1 HORIZONTAL DRILLING, BORING AND MILLING MACHINE

The accompanying illustration shows a recent design of the horizontal drilling, boring and milling machine made by the Detrick & Harvey Machine Co., of Baltimore, Md. The machine shown is the No. 1 or 50-inch size, so proportioned as to drill and bore anywhere on a surface 50 inches square.

The column is a box section tapered to a broad base, which is gibbed with a sliding fit to the bearing on the runway. This bearing is carefully scraped and guides the column between long narrow surfaces which preserve the alignment with great accuracy. The saddle or head has a vertical movement on the column by hand or by power; the same is true of the column in its movement on the runway. Six changes of power feed are provided in both these movements, of suitable range for milling operations. The bed-plate and length of runway are made in sizes to suit the requirements of the purchaser. Suitable T-slots for clamping the work-table and the outboard boring bar support, are provided.

The steel spindle carried by the saddle is back-gearred at the front end, giving a direct drive for heavy face milling

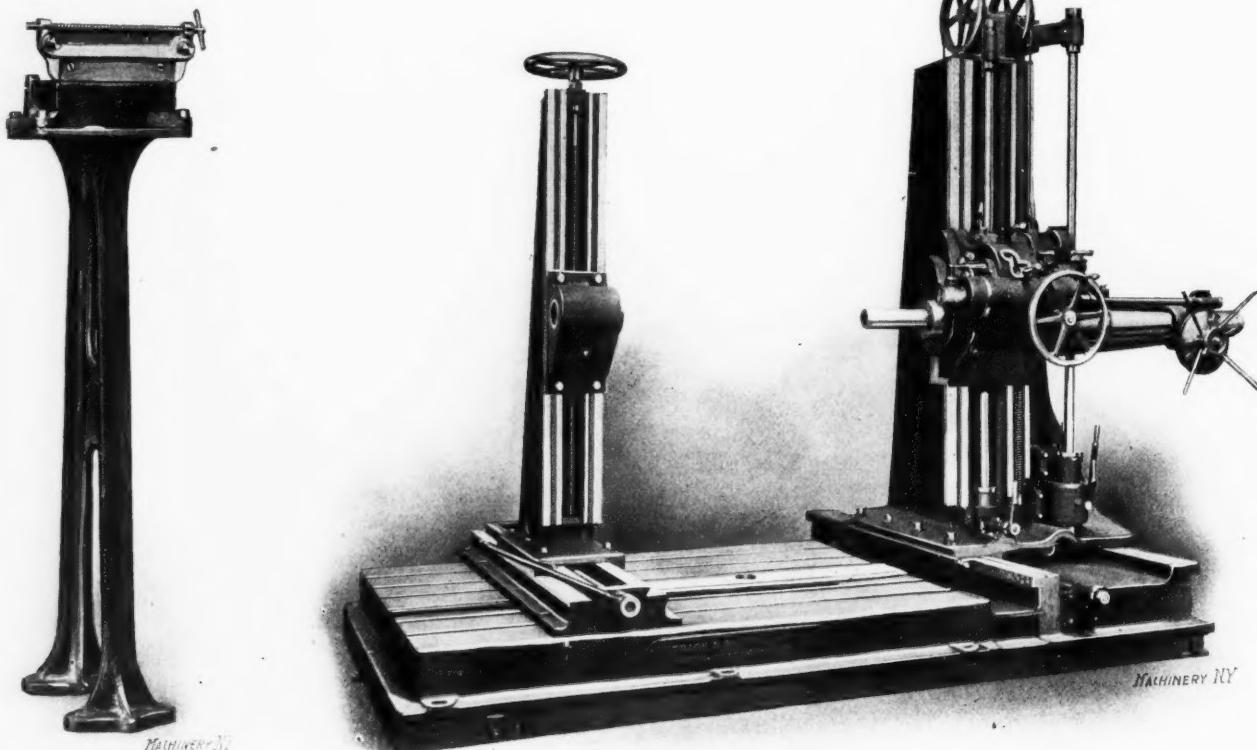


Fig. 2. Tool Mounted on Stand

New Design of the Detrick & Harvey Horizontal Boring, Drilling and Milling Machine

thus been laced, the guide-screw is threaded out of the lacing. After the other end of the belt has been treated in the same manner, the lacings for the two ends are pressed flat in the vise, and then interlocked with each other. A rawhide pivot pressed in between the two, forms the hinge and completes the joint.

A belt thus laced is provided with a joint which has a maximum of strength, and a thickness no greater than that of the belt. At the same time, it is flexible enough to run over a very small pulley at high speed. The staggering of the holes greatly increases the efficiency of the joint. There is often times great advantage in lacing a belt away from the machine, in places where such an operation in place would be dangerous or even impossible. A simple insertion of the raw-

operations; the end of the spindle will be threaded if required, for carrying these heavy cutters. A No. 6 Morse taper hole is provided for driving end mills, drills and boring bars. The twelve rates of spindle speed range from $5\frac{1}{2}$ to 125 revolutions per minute. These are controlled by levers on the saddle within convenient reach of the operator. The spindle reverse for tapping is governed by a lever at the bottom of the driving shaft on the column.

The following dimensions will give an idea of the capacity of the machine. The spindle has a maximum vertical adjustment on the column of 50 inches, and a standard traverse of the column on the runway of the same amount. The spindle is 4 inches in diameter with a feed of 30 inches. The standard work bed has 50 by 84 inches of surface. With this size

of work bed, the maximum distance from the end of the spindle to the outer support is 61 inches, and the floor space occupied is 12 by 17 feet.

This machine will be furnished if desired with a universal tilting and rotating table by means of which the operator can drill and bore at any angle anywhere on five sides of a cube. This table can be firmly clamped in any position and moved in a direction parallel with the spindle, toward and away from the column. It is provided with T-slots and a central hole. A rotating table without the tilting feature can be furnished when desired.

Other extras which the manufacturers are prepared to furnish are graduated scales for the various adjustments, rotary pump for providing lubricant when drilling on steel, motor drives, etc. The machine will also be furnished without the bed-plate if desired, or for use as a portable machine. It is made in four other sizes to cover the range from 40 to 96 inches maximum capacity of vertical and horizontal movements.

STROMBERG ELECTRIC CHRONOGRAPH

An electric chronograph or time recorder for registering the exact time of the entrance or departure of employees from manufacturing or mercantile establishments, is shown in the illustrations presented herewith. Another model of the chronograph, intended for general office purposes, was illustrated and described in the New Machinery and Tools department of the February, 1909, number. Those who read that description will probably recall that this instrument is a radical departure from the usual time-recording device in that it, together with any number of instruments both for general office and in-and-out recording, can be connected in the same circuit and operated by one master clock, thereby

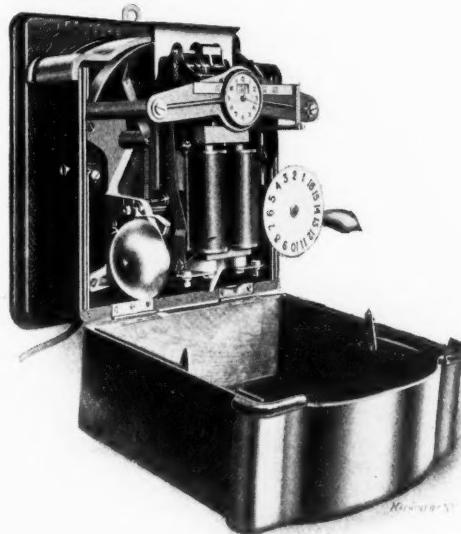


Fig. 1. Stromberg Electric In-and-out Time Recorder Opened to expose Mechanism

insuring absolute uniformity and agreement. It will thus be seen that all of the clock mechanism is removed from the recorder itself, so that the jar when registering does not in any way affect the delicate mechanism of the controlling timepiece.

Another salient feature of the chronograph is that it prints on the front of the card instead of on the reverse side, as is the case with other makes of in-and-out recorders. It is not necessary to provide a special master clock, as any factory clock equipped with a second hand can be used. The illustration, Fig. 1, shows the interior mechanism of the instrument. The printing wheels and the hand of the dial on the side of the chronograph are moved by a simple magnetic action controlled by a make-and-break device attached to the master clock. Either direct or alternating 110-volt current storage battery or primary batteries may be used to operate the instruments. For alternating current, however, a rectifier, which will be furnished by the company, is necessary to convert the alternating to direct current. The illustration,

Fig. 2, shows the chronograph with the time-card cases on either side. The instrument is so made that there are no bolts, screws or other parts exposed, which can be tampered with by a malicious employee. The model for in-and-out recording is fitted with an adjustable gage which insures the recording of time in the proper place on the card, without any manipulation on the part of the operator beyond inserting

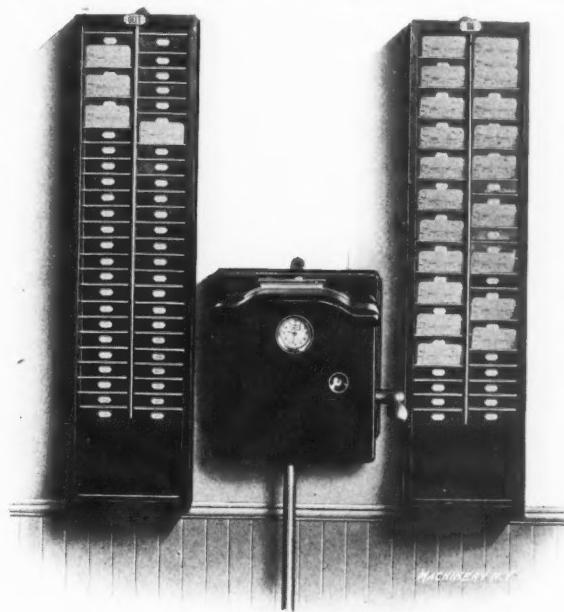


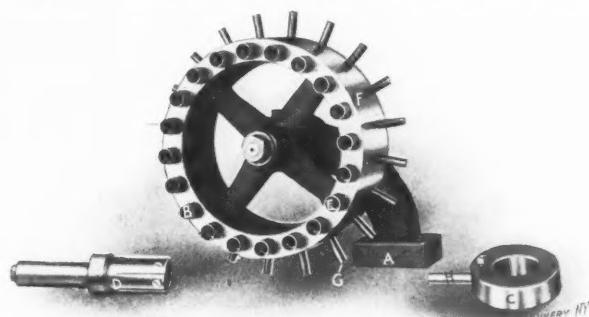
Fig. 2. The Chronograph and the Time-card Filing Cases

the card into the chute and depressing the printing arm in the usual manner. When this is done, an exact and indelible record of the time of arrival or departure is accurately recorded. The chronograph is manufactured by the Stromberg Electric Mfg. Co., 108-128 North Jefferson St., Chicago, Ill.

CLEVELAND ROTARY MAGAZINE ATTACHMENT

A special rotary magazine attachment has just been brought out by the Cleveland Automatic Machine Co., Cleveland, Ohio, that is exceedingly simple in its construction and yet, undoubtedly, a most effective piece of mechanism. This is not a regular attachment, but simply a new fixture which has been devised to handle some of the second-operation work which, because of peculiar shapes, cannot be easily handled in a standard tilting magazine. This new drum magazine can be applied to any "Cleveland" automatic, and it is recommended by the company to those having thousands of one-piece to make which are exceptionally large at one-end, small in diameter, but long and light.

A view of this magazine is shown in the accompanying illustration. When it is attached to the machine, the bracket



Special Rotary Magazine Attachment for Cleveland Automatics

A rests on top of one of the bed arms, and the hole located in position B, is in line with one of the turret holes. The collar C fits on the cam-shaft, and a conveyor D is held in the turret of the machine. Directly back of the hole in position E, there is a spring plunger which enters the rear of the hole at this point and serves to hold the drum rigidly with

the supporting bracket *A*. This plunger, however, allows drum *F* to be indexed to the next hole when pressure is applied to one of the pins projecting from the periphery of the drum.

In operation, the pieces of work are placed in the bushings which are inserted in the face of the drum *F*. When the conveyor is carried forward by the turret, it removes the piece from bushing *B*, and when the turret recedes, the pin *H* in the collar *C* engages pin *G*, thus indexing the drum to the next position. When this magazine is attached to an automatic it is simply necessary to keep it filled with work, and one man or boy can easily attend to six machines. As is evident, the mechanism is exceedingly simple, and this is always a reliable guarantee against trouble of any kind.

PRYIBIL SELF-BALANCING ELLIPTICAL CHUCK

The elliptical chuck is an old piece of apparatus, made in a number of different designs by different manufacturers. It finds a limited application in machine work, and a more extensive one in wood-working and metal spinning. In wood-working it is used for such operations as the turning of oval picture and mirror frames, ornamentations, etc.; the large variety of elliptical and oval shapes in sheet metal requires its use for metal spinning. These more common uses of the device require high speeds. In this respect the elliptical chuck has hitherto been defective, owing to the fact that the

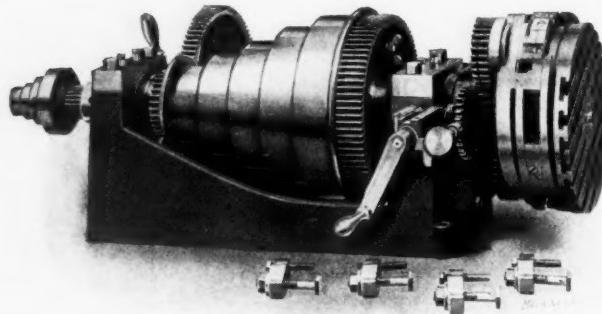


Fig. 1. Prybil Self-balancing Chuck, adapted to Heavy Work

reciprocating parts are unbalanced, causing excessive and dangerous vibration if it were attempted to run at a rate of speed such as would be used for circular work of a corresponding character. In the chuck herewith illustrated and described, made by P. Prybil, 512-524 West 41st St., New York City, the reciprocating parts have been balanced so that the

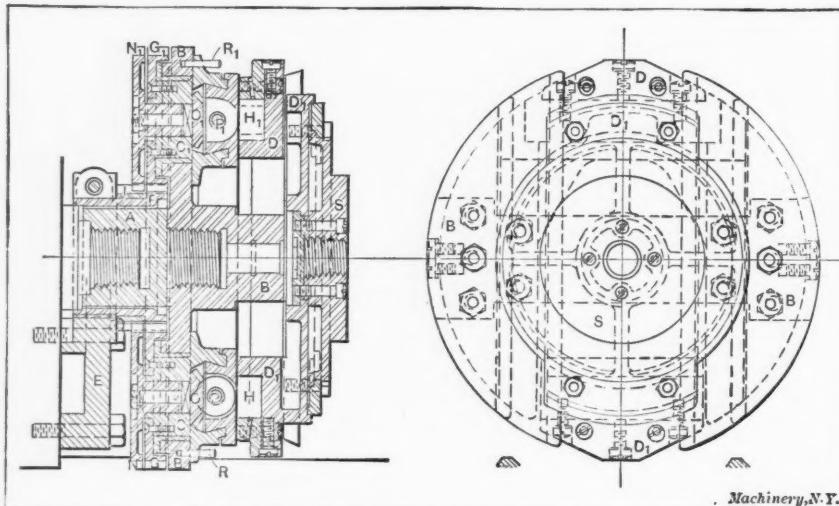
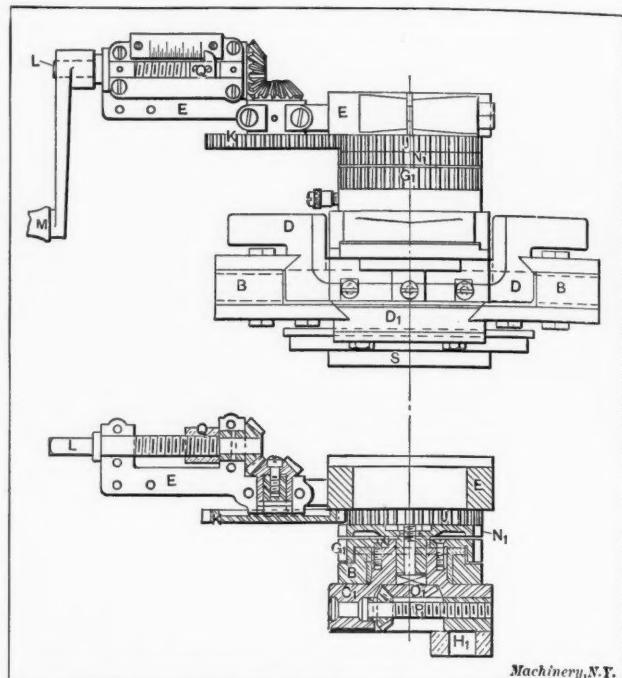


Fig. 2. Section and Face View of Chuck, showing Construction

chuck can run smoothly at high speeds. This greatly increases its capacity, giving a large return in product per hour of work, for the extra mechanism employed.

Fig. 1 shows the heavier form of chuck used for metal turning, attached to an engine lathe head-stock; Figs. 2 and 3

show details of the construction. A false nose *A* is screwed onto the lathe spindle to extend the latter sufficiently to bring the chuck clear of the head-stock. Screwed onto this false nose, and therefore revolving with the spindle, is the main frame *B* of the chuck. This main frame is in the form of a cross



Machinery, N.Y.

arm (this construction is not very clearly shown in the engravings) whose vertical arms carry bearings for revolving cranks *C* and *C*₁, while the horizontal arms, seen in Fig. 3, are provided with gibbs for the two reciprocating slides, one in back at *D* and the other in front at *D*₁.

The bracket *E*, bolted to the face of the head-stock, has keyed to it a spur gear *F*, concentric with the spindle. Cranks *C* and *C*₁ have screwed and doweled to them gears *G* and *G*₁, meshing with this gear *F*. Crank pins at *H* and *H*₁ (so mounted in cranks *C* and *C*₁ as to give an adjustable stroke as will be described) are pivoted in square blocks fitted to slots in slides *D* and *D*₁. It will thus be seen that, as the spindle of the lathe, false nose *A*, and body *B* revolve together, gears *G* and *G*₁ will roll around on stationary gear *F*, revolving cranks *C* and *C*₁, and thus causing, through crank pins *H* and *H*₁, the reciprocating of slides *D* and *D*₁. Slide *D*, travels back and forth across the face of the chuck, carrying the work, which thus receives a proper movement for elliptical turning. Slide *D*, on the other hand, on the backside of the chuck, moves always in opposite directions to slide *D*₁. Owing to the fact that these two slides are practically equal in weight, they balance each other in their movement, and permit the rotating of the chuck at a high rate of speed. This is the important innovation in the design.

Adjustments are provided for all the important sliding bearings, such as those for slides *D* and *D*₁ in body *B*, and for the squared blocks *H* and *H*₁ in slide *C*. The face-plate *S*, which is mounted on slide *D*₁ can be rotated and clamped in any position to bring the major axis of the ellipse in any required relation with the work being operated on.

There is another feature which adds greatly to the usefulness of this tool—the provision made for adjusting the eccentricity of the movement while the chuck is revolving. By this means, the difference between the major and minor axes of the ellipse being turned, can be adjusted as required, without stopping the work and without measurement. On the hub of stationary gear *F* is mounted a gear *J* (see Fig. 3), mesh-

ing with a gear K , having a bearing in bracket E . Bevel gears connect this with a shaft and crank L and M , by means of which gear J may be revolved. Gears N and N_1 , which also mesh with J , are keyed to bevel gears O and O_1 , which in turn operate adjusting screws P and P_1 , which are threaded into the adjustable crank pins H and H_1 .

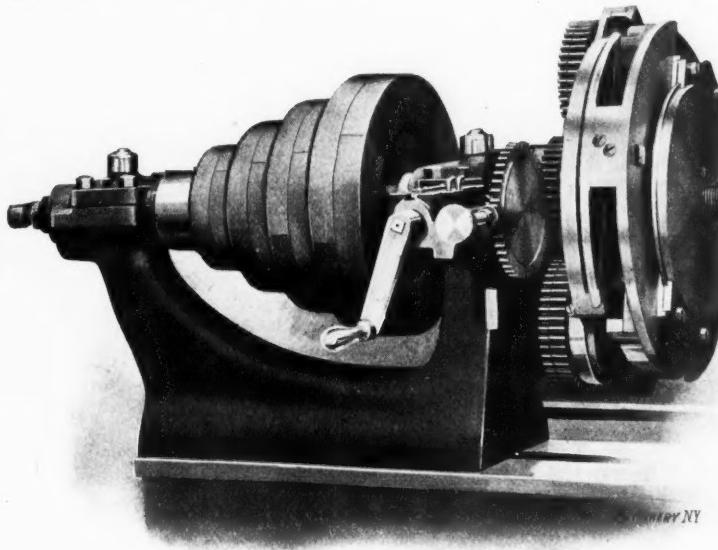


Fig. 4. Lighter Design of Chuck, used for Wood Working and Metal Spinning

It will be seen that with J and F both fixed in position, gears N and G , and N_1 and G_1 , will rotate together without any movement relative to each other, so that the adjusting screws P and P_1 will be stationary and the adjustment of crank pins H and H_1 will remain unchanged. When, however, gear J is revolved by crank M , N is moved with reference to G , and N_1 with reference to G_1 , so that adjusting screws P and P_1 are rotated and the throw of crank pins H and H_1 is increased or diminished. By this means the difference between the major and minor axes of the ellipse being turned is increased or diminished at will. As may be plainly seen, it makes no difference whether or not the machine is running, for while gears N and G are running around gears J and F , the adjustment can be made either way.

Adjusting shaft L is threaded and is provided with a nut Q , having an index finger reading the amount of eccentricity on a fixed scale. This is a great convenience in setting up the

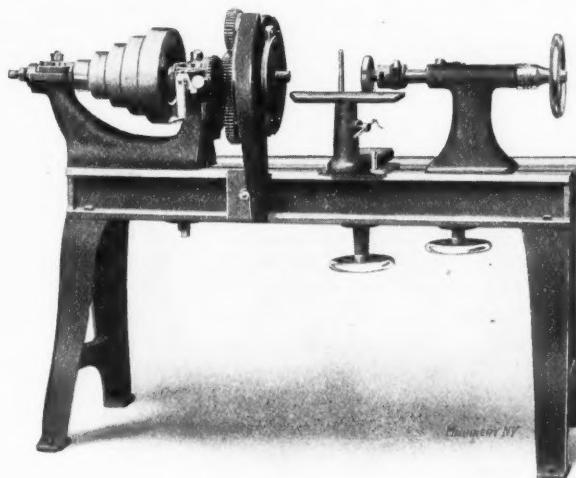


Fig. 5. Elliptical Chuck mounted on Spinning Lathe

device. To insure the proper relation of all the parts when the chuck is removed from the work, taper pins R and R_1 (see Fig. 2) are inserted to lock the cranks in position. This in-

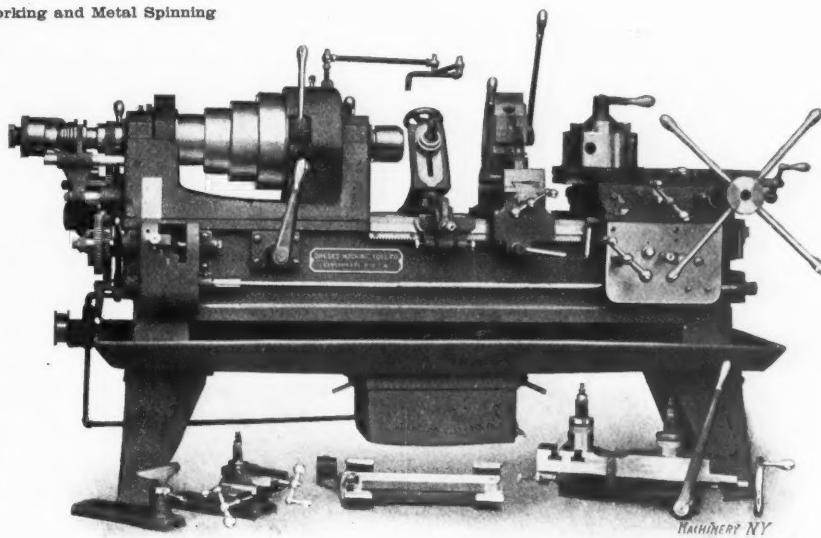
sures the proper action of the chuck when it is again mounted in place on the machine.

Fig. 4 shows a larger and lighter form of this fixture, operating on the same principle used for wood work and metal spinning. It will be noticed in both Figs. 1 and 4 that a positive means of locking is provided, by a bolt entering the spaces between the teeth of gear K , so that no accidental change of adjustment is possible. In Fig. 5, this interesting device is shown attached to a metal spinning lathe, provided with a proper guard for protecting the workman from the mechanism.

DRESES 20-INCH FULL UNIVERSAL "MONITOR" LATHE

The "Monitor" lathe herewith illustrated and described is built by the Dreses Machine Tool Co., Cincinnati, O. It is designed for general brass and similar work of a heavy character, made from castings, forgings and stock. It is provided with such adjustments as make it possible to manufacture, without special tools, many pieces for which it would not pay to equip the ordinary machine of this type.

The turret carriage feed mechanism is similar in design to that of the standard engine lathe. A positive geared feed is provided, with a quick gear change box, giving eight variations.



A Monitor Lathe with Universal Adjustments for a Wide Range of Work

These changes cover the ordinary standard pipe threads, as well as giving suitable turning and boring feeds. Provision is made for obtaining other feeds and pitches by the use of change gears.

The turret slide is in two parts, with a taper dove-tail plate interposed, on the lower side of which is carried a shoe swivel sliding on the bar of the taper attachment. The latter is shown dismounted from the machine, lying on the floor under the center of the bed. This, when in use, slides on the inside of the bed and is held in place by a suitable clamping bolt. It can be readily removed and no special provisions are necessary in the design of the bed for holding it. By its use, inside or outside, taper or straight threads, can be chased by a tool in the turret without the use of a tap or die.

The upper section of the intermediate dove-tail plate has a screw with a ball crank for cross feeding by hand. Positive stops are provided for setting the turret holes in alignment with the spindle. The turret slide is provided with a pilot wheel for rapid movement, and with a screw for finer adjustments. The pilot wheel may be removed from its stem so as to be out of the way when the screw feed is in constant use. The turret is adjustable for wear on its seat. The locking bolt withdraws at the return movement of the top slide, making the rotation of the turret semi-automatic.

The head-stock is provided with carefully enclosed friction

back gears, with clutches of the toggle joint type, so designed that the whole operating mechanism can be put in place or removed without taking out the spindle. The automatic chuck is operated with the handle shown below the cone pulley.

Various forms of cross-slides, rests, etc., are provided, as shown in the illustration, fitting the machine for a wide range of work. The chasing bar has a yielding follower holder, which maintains contact with the leader when chasing taper work. The taper attachment for the chasing bar is provided with knurled screws for minute adjustment. A vertical forming rest is also shown in place on the bed. The cutting-off rest is shown on the floor at the right, and hand and slide rests at the left. The taper attachment has already been mentioned.

This lathe is furnished with a pan, oil reservoir, pump and piping, adapting it for iron and steel as well as brass. It swings 20½ inches over the V's, has a bed 6 feet 6 inches long, and weighs about 3,600 pounds.

CUTTER GRINDING HEAD FOR B. & S. UNIVERSAL GRINDING MACHINES

The cutter holding head and its attachments, shown herewith, is made by the Brown & Sharpe Mfg. Co., of Providence, R. I. It is similar in design to the corresponding parts pro-

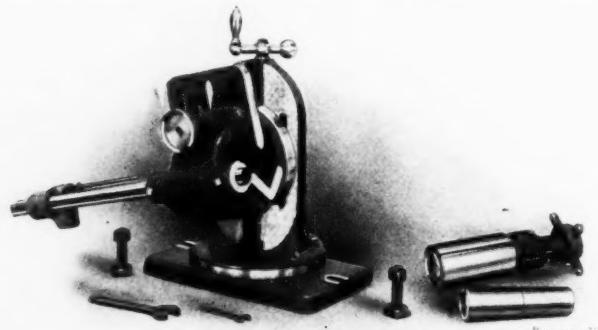


Fig. 1. Universal Cutter Sharpening Head and Equipment

vided for their No. 13 universal and tool grinding machine, but is arranged to be used on any of the universal grinding machines made by the builders. The device should, therefore, prove a great convenience in shops whose requirements are so small as to make the purchase of a special cutter and reamer grinding machine inadvisable, but whose management still desires to obtain the benefit of the economical production only possible with milling cutters kept in proper cutting condition.

The attachment consists principally of a swivel vertical column, upon the slide of which a swivel head for supporting

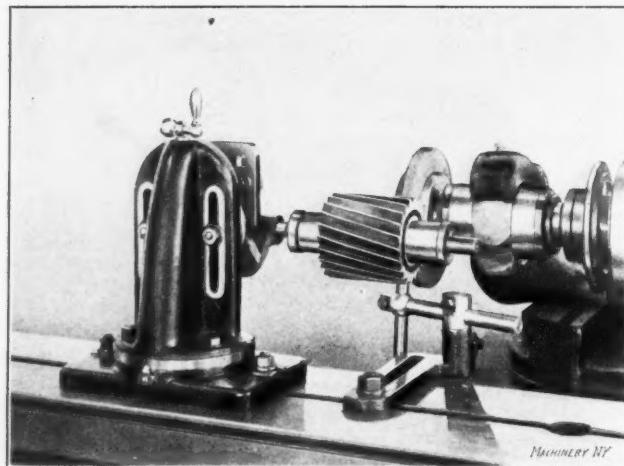


Fig. 2. Spiral Milling Cutter being sharpened on Cutter Bar

the work is fastened. The vertical column is mounted on the base-plate which, in turn, is securely fastened to the table by means of a clamping bolt at each end, passing through slots in the base casting.

The base plate is of solid construction and has a large bearing surface upon the table, thus insuring a rigid support for the vertical column. It is made in two styles, one of which has a tongue on the under side to fit the T-slot in the table of universal machines; the other has a longitudinal V-way that fits over a way of like design on the table of the No. 13

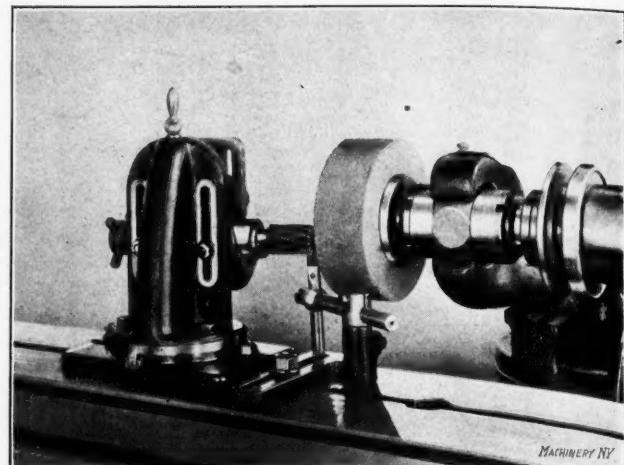


Fig. 3. The Taper Shank Mill Sleeve in Use

universal and tool grinding machine. In either case the alignment of the head, with relation to that of the table, is correctly and simply maintained. The column swivels in a horizontal plane and may be set at any angle with the table. A dial graduated to degrees, encircling the entire circumference of the base, facilitates quick adjustment to any desired angle. Two bolts, which pass through the base and slide in circular slots in the base plate, serve to securely clamp the column.

In the convenience and adaptability of the work head are found the features of the attachment. It is simply and compactly constructed and has a large bearing surface on the vertical column, thus making it fully capable of resisting vibrations due to the action of the wheel on any work within

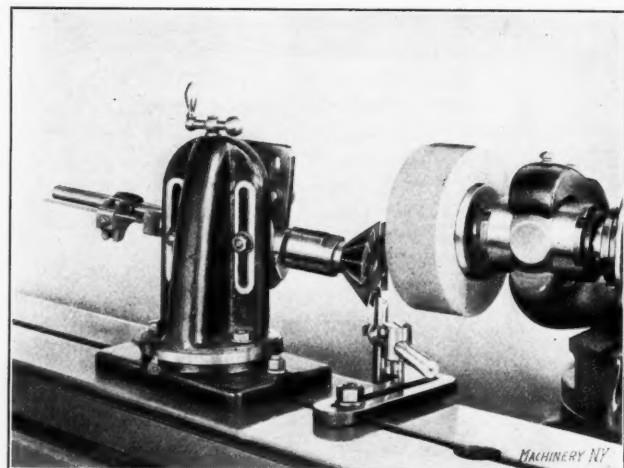


Fig. 4. Grinding the End Teeth of an Angular Cutter, supported in the Vise

the range of the attachment. The head swivels in a vertical plane and may be clamped at any angle up to 90 degrees either side of zero, its position being indicated by a dial graduated to degrees on the circumference of the base. The clamping bolts pass through circular slots in the head casting and vertical slots in that of the column. Provision is made for a vertical adjustment of 4 inches, by means of a ball crank at the top of the elevating screw. With the head at its extreme height, work up to 16 inches in diameter will swing over the table; by turning the head at right angles, light work up to 24 inches in diameter can be accommodated.

Two methods of holding work are provided; milling cutters being clamped directly by their shanks or arbors in a V-shaped vise, while work requiring sliding shells is supported on a rod known as the cutter bar. The vise is rigid and readily adaptable to many varieties of work. The lower jaw consists of a heavy V-shaped trough in which the shank or arbor of the work is placed. The upper jaw pivots, and is adjusted by

means of a hand clamp screw. A long drop-back rest is carried by the upper jaw. To fasten work, this rest is lowered until it touches the piece and is clamped in this position. Then, by simply adjusting the hand clamp wheel the drop back rest is securely fastened upon the piece. An adjustable center rod is provided for supporting and taking the end thrust of work having a tapered shank; it may also be used for taking the end thrust of centered pieces that are not clamped solidly in the vise while grinding.

The cutter bar is made of steel, $\frac{3}{4}$ inch in diameter, and has a flat side for clamping screws to seat upon without injuring the working surface. It is supported in bearings in the work head casting and, in addition to holding work to be ground, serves as an arbor for the upper portion of the vise to pivot upon. It can be adjusted to any length and clamped by means of set screws. An additional cutter bar $\frac{3}{8}$ inch in diameter can be furnished when so desired.

A device known as a taper shank mill sleeve is furnished with the universal head and is particularly useful in grinding work having taper shanks, such as end mills, etc. It consists of an outer sleeve that can be rigidly clamped in the vise, and a taper bushing in which the work is held. The bushing is free to turn in the sleeve, but is held positively against the end of the sleeve by a spring. A handle fastened to the outer end of the bushing serves to hold the work against the tooth rest as well as for indexing. Two taper bushings are furnished with the attachment; one No. 7 and the other No. 9.

By the employment of this device, it will be seen, reamers, milling cutters, counterbores, countersinks and a large variety of other cutting tools can be quickly and accurately sharpened. The attachment is simple in design, convenient in operation, and is easily removed and placed in position.

COLBURN FLOATING REAMER HOLDER

The tool herewith illustrated and described is intended for holding reamers in turret machines, particularly vertical boring and turning machines with turret heads, when it is necessary to so support the reamer that it will find its own center in the work. In other words, the tool is a floating holder. It is impossible to depend on having the turret near enough in line or the reamer straight enough to permit holding it rigidly for a power operation. Floating reamer holders

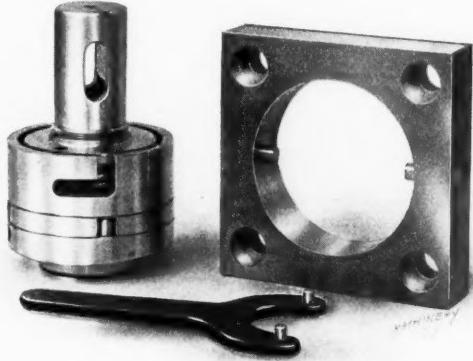


Fig. 1. Colburn Floating Reamer Holder

have been made for many years in individual shops for home use. The design here described is intended to make a commercial product of the device, the object being to provide a construction which would be thoroughly practical and satisfactory in every particular, and which could at the same time be readily adapted to machines of any make.

In Fig. 1 the tool is shown assembled; Fig. 2 shows it separated into its component parts; Fig. 3 shows it in use in the machine, and Fig. 4 is a detailed drawing. The construction of the tool will perhaps be best understood by referring to Figs. 2 and 4.

The reamer, which may be of the solid or shell, adjustable or non-adjustable styles, is mounted by its taper shank in socket *E*. The latter is driven from sleeve *C* by a universal coupling arrangement. This consists of a collar *F*, interposed between *C* and *E*, and provided with slots closely engaging pins *G* which are fast in *E*, and pins *G₁* which are fast in *C*.

E and the reamer which it contains are thus allowed to find their own centers with relation to the work, there being no cylindrical fit between socket *E* and sleeve *C*. At the same time a strong and direct drive is provided. This coupling will be seen to be an interesting use of a well-known mechanical principle. To keep the faces of *C*, *F* and *E* tightly pressed

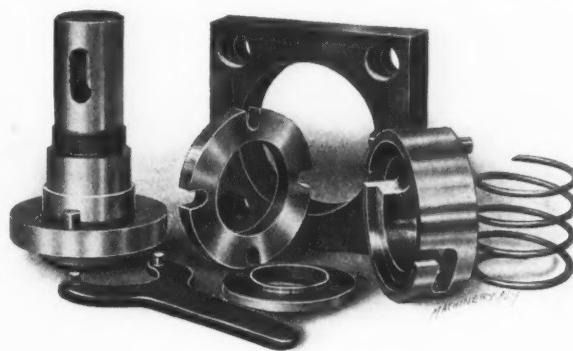


Fig. 2. Reamer Holder separated into its Component Parts

together, nut *I* is threaded onto the socket, compressing spring *H* against its seat in *C*. The spring may be adjusted to be strong enough to overcome the weight of the reamer and its shank, and to keep the parts of the holder tightly pressed together.

The socket and sleeve are held in a base *A* by a bayonet lock arrangement, which permits their instantaneous insertion or removal, as may be required. The bayonet grooves

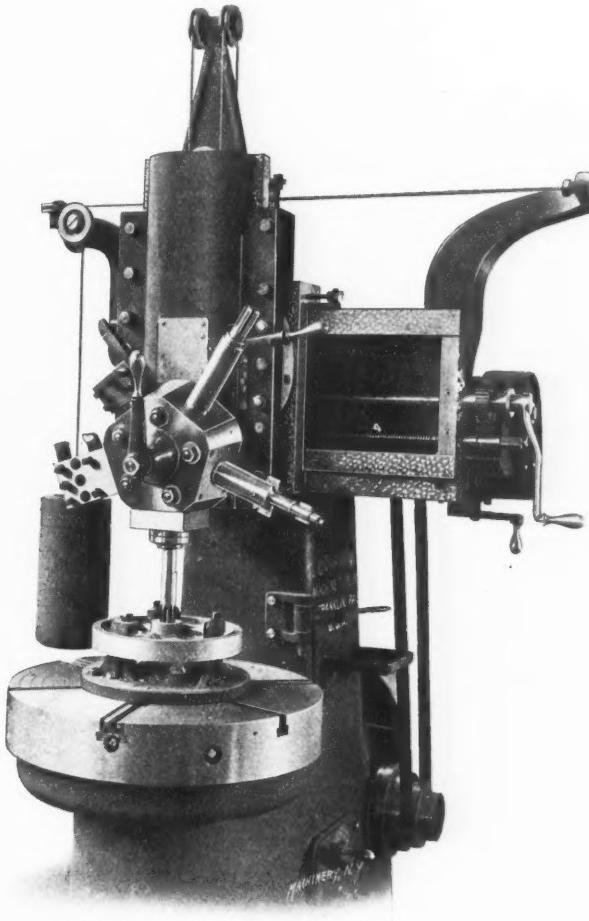


Fig. 3. Reamer Holder in Use in Vertical Boring Mill

are formed in sleeve *C*, and they are engaged by pins *B* driven into *A* as clearly shown in the engraving. Base *A* is the only member which has to be fitted to the turret; this will be provided by the makers, the Colburn Machine Tool Co., Franklin, Pa., for any dimensions to agree with the machine on which it is to be used.

The advantage of this device may be summed up as follows. It is a commercial product made on a manufacturing basis after a carefully thought out design, instead of being a home-

made and make-shift contrivance. It will fit any make or style of reamer, it only being necessary to provide a shank having the usual Morse taper. It can be used on any make or style of boring mill having a turret with flat sides. It will hold the reamer parallel with the axis of rotation at the same time that it permits it to center itself.

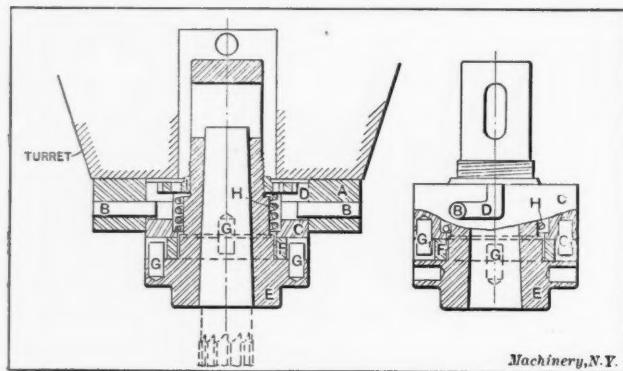


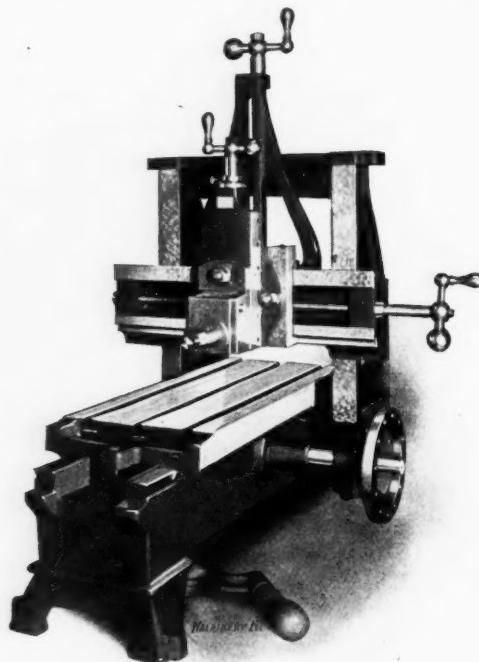
Fig. 4. Details of the Construction

These holders are made in two sizes. The No. 1 has a No. 4 Morse taper socket capable of holding reamers up to 3 inches in diameter; the No. 2 size has a No. 5 Morse taper socket, and will carry reamers up to 4 inches in diameter.

SCHNEIDER HAND-OPERATED METAL PLANER

The illustration shows a metal planer of small size, built by the Schneider Machine Tool Co., 20 East 9th St., Cincinnati, O. This planer is built for hand-operation only, so is especially fitted for model, experimental and tool work.

The illustration shows that the machine is built on the general lines of the heavier power-driven planers. It is provided with a modification of the cross-rail elevating mechanism, however, which is more appropriate to a machine of this size. A slide or frame attached to the back side of the cross-rail extends upward above the top of the housings, where it forms a bearing for a single elevating screw. A slot cut in this frame is guided by a bearing block attached to the hous-



Hand-operated Planer for Tool, Model and Experimental Work

ing tie-piece. By this means the rail is kept accurately in alignment with the surface of the table even though but one screw is used instead of two as usual.

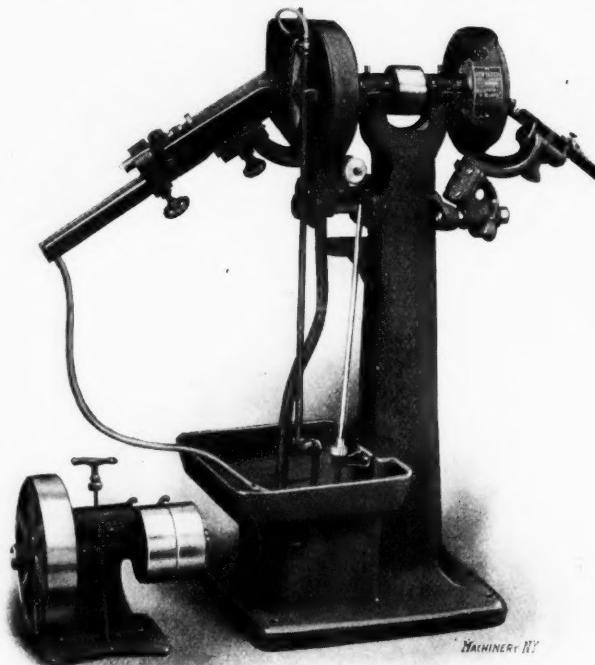
A rack and gear are used as in larger planers for reciprocating the table; the gear is mounted directly on the shaft to which the hand-crank is attached. The hand-wheel on this shaft, as shown, is provided with a series of holes into any one of which a locating pin on the crank may be inserted, thus

permitting the latter to be set in any position that is convenient for the cut on the table. It also permits rapid change in position whenever required by the work.

The machine is substantially built to secure the stiffness required for accurate work. The bed has flat ways and is provided with oil channels and pockets to prevent the lubricant from running down outside or inside of the bed. The table takes in 10 inches between the housings, and 8½ inches under the cross-rail. The rack is 24 inches long. An automatic cross-feed will be furnished if desired.

IMPROVEMENTS IN THE "YANKEE" DRILL GRINDER

An improved "Yankee" drill grinder has lately been placed on the market by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich. Some difficulty has been experienced in previous constructions in regard to the handling of small drills in a holder of sufficient capacity to take care of the large sizes of drills which are in more common use. In the machine now placed on the market this difficulty has been eliminated, and the machine combines a capacity for handling



"New Yankee" Drill Grinder with Improved Drill Holder for Smaller Sizes; built by the Wilmarth & Morman Co., Grand Rapids, Mich.

large sized drills with the greatest convenience in grinding small drills. A large holder is furnished for wet grinding of large drills, having a maximum normal capacity for 2½-inch diameter drills with a minimum capacity for ¼-inch drills. A smaller holder, however, is also provided in which, with greatly increased convenience, drills from a maximum of ½-inch diameter down to a minimum of No. 60 drill gage size can be ground. A finer grade of emery wheel is provided for the smaller drills, and, as seen in the accompanying illustration, two operators can be working, one on each of the two holders, without interfering with each other. Both holders embody the regular "New Yankee" construction, by which the time-consuming preliminary adjustments are avoided by means of the angle of the V-shaped groove or trough which automatically locates each different size of drill in the right position for grinding.

The clearance can be adjusted when required, so as to provide for either the small amount of clearance desirable for working in hard steel, or the much greater clearance necessary for drilling softer metals. The normal clearance, however, is maintained for drills of different sizes for ordinary service, without any adjustment being required on the part of the operator. The machine shown in the accompanying engraving is designated by the makers as the style "WPL." Its general design, outside of the features referred to, is entirely along the same lines as that of the well-known regular type of the "New Yankee" drill grinders.

ANDREW AUTOMATIC CYLINDER BORING MACHINE

M. L. Andrew & Co., of Cincinnati, O., make a multiple drill of the double housing and cross-rail type, which we have before illustrated in a variety of designs for a variety of applications. (See, for instance, the department of New Machinery

three spindle speeds are designed to be suited to the different diameters of holes in the work in automobile cylinder operations.

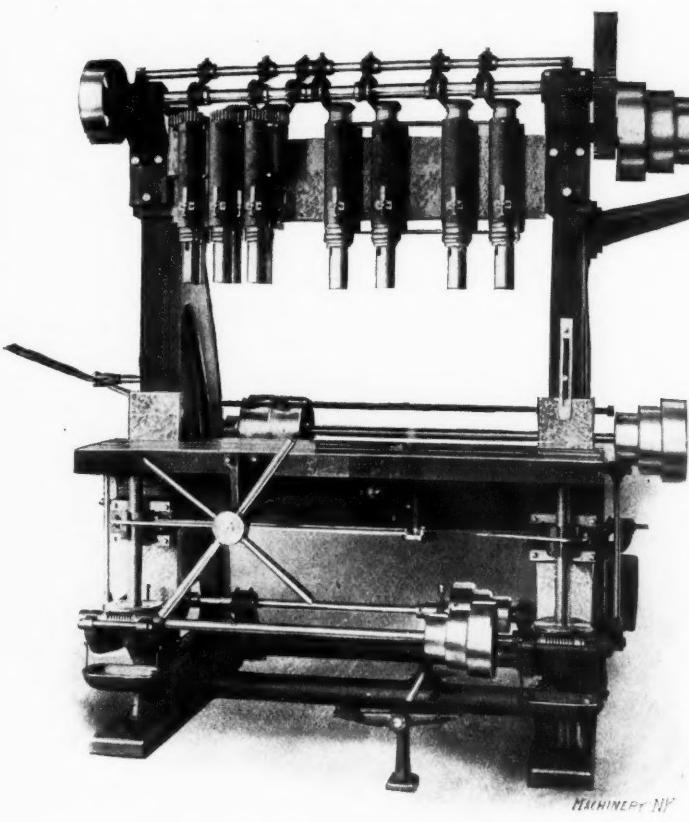
GANG RADIAL DRILLING MACHINE

The radial drill made by the Wm. E. Gang Co., Cincinnati, O., has been redesigned, as shown in the engraving.

The general design of this radial drill is well known. The spindle is driven from a horizontal shaft which passes through the swinging column, where it is connected by gearing with the vertical drive-shaft. This construction gives much more direct drive than usual. Another distinctive feature of the machine is the placing of the power-elevating mechanism on the arm instead of at the top of the column. The screw is thus a stationary one acted on by a revolving nut.

In the new design, the particular point of interest is a new spindle drive mechanism. *A*, in Fig. 2, is the horizontal driving shaft, passing through the column as described. This shaft has keyed to it a pinion *B*, driving bevel gears *C* and *D* in opposite directions. These latter revolve loosely on the shaft, and are provided with internal seats against which friction rings may be expanded, so that either of them can be connected with shaft *F*. This double friction clutch is operated by lever *N* through collar *E*. By this means the spindle is quickly reversed in either direction. Spur gear *G* is solid with shaft *F*, and spur gear *I* is keyed to it. These mesh with gears *H* and *J* respectively, which run loose on sleeve *L*. Sliding jaw clutch *K*, controlled by lever *O*, may be operated to engage either one of these with the shaft. This corresponds to the usual back gear provision, giving eight changes of speed with the cone pulley drive, or twelve with the speed box.

An important point in the drive thus described is the fact that the friction clutches for reversing operate between the high-speed shafts *A* and *F*—that is to say, the back gears are placed between the



Andrew Multiple Spindle Drill Modified for Cylinder Boring

and Tools in the November, 1907, and the April and November, 1908, numbers of MACHINERY.) Still another modification of this machine is herewith illustrated.

This particular design is intended for the boring operations on automobile cylinders. The multiple spindles are divided into two groups. The three shown at the left are permanently gibbed and bolted to the cross-rail, in such a position that they can bore the four valve seat chambers and the two spark plug holes, in the time required to finish one hole on the single-spindle machine. The four spindles at the right of the cross-rail are gibbed to the rail, but are adjustable on their mounting. In the arrangement shown, they are tied together by gages at the top and bottom to preserve definite center distance. These may be used for boring the cylinders themselves, or for boring angle holes for cylinder plugs.

The general design of the machine is the same as those we have previously illustrated. The spindles are of high carbon steel, running in phosphor-bronze bearings with ball thrust collars. They will be provided with either No. 4 or No. 5 Morse taper sockets as desired. The table is fed upward with steel feed-screws, operated by carefully-made worm-gearing. The feed-screw nuts are of phosphor-bronze, opened and closed by a hand-lever on the front of the table; the feed throw-out is automatic. The pilot-wheel controls the rapid movement or adjustment of the feed. The table itself is made extra heavy, is provided with T-slots, and is counterbalanced. The

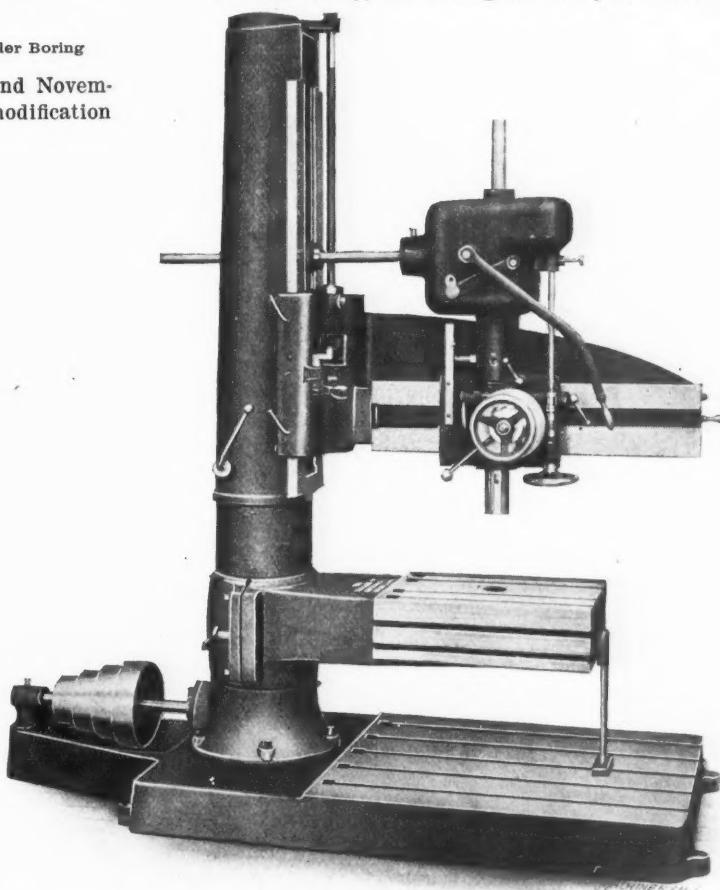


Fig. 1. Gang Radial Drilling and Tapping Machine

clutches and the spindle. By this means they are relieved of the excessive strain that would be thrown on them in such work as heavy tapping which requires the reversal of the

spindle while the tap is lodged in the work. The friction clutch operates without shock or jar.

Another important improvement is the depth gage and automatic stop. The gage is shown at *R*, and the adjustable tripping dog and pointer at *S*. The point of novelty lies in the fact that the graduated scale, instead of being on the spindle and moving with it, is attached in a stationary position on the head. The adjustable dog and pointer is clamped

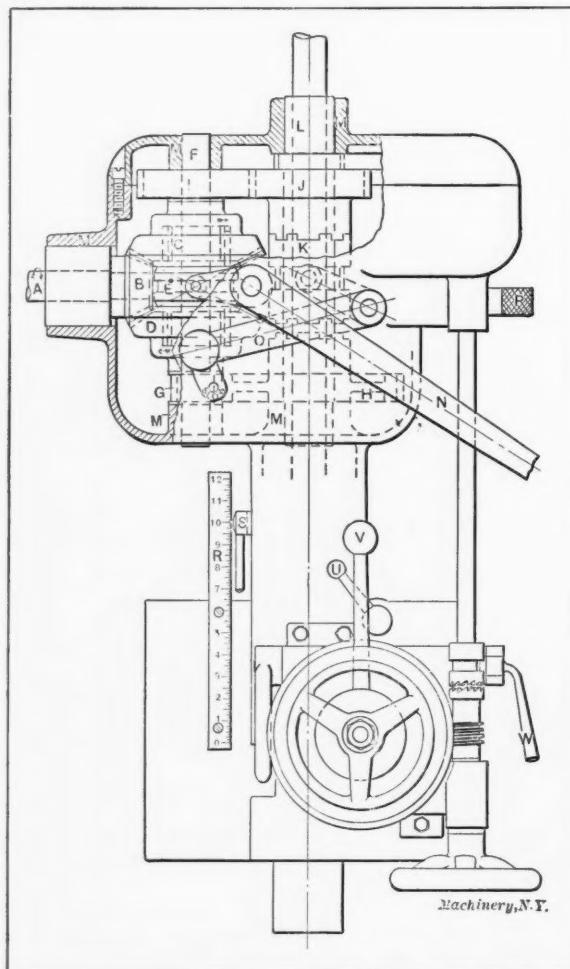


Fig. 2. The Improved Spindle Drive of the Gang Drill

in any required position by a bolt seated in a T-slot in the spindle sleeve. Thus arranged, with the zero point at the lower end of the graduated scale and in a fixed position, all the operator has to do in preparing to drill or counterbore a hole to a given depth is to bring the tool down onto the surface of the work, set the pointer on dog *S* opposite the graduations on the scale corresponding to the required depth, tighten the pointer and start the feed. When the pointer gets to zero, the feed will be knocked out automatically, and the spindle can travel no further. All depths are read from zero.

Four rates of feed are provided on this machine—0.008, 0.011, 0.014 and 0.017 inch per revolution of the spindle. The changes are made by turning knurled knob *P*. The feed is taken from a positive connection with gear *J*, through the change mechanism and a worm and worm-gear connection for the rack-pinion. The worm-gear drives the rack-pinion through a friction clutch, operated by quick return lever *V*. Lever *W* operates the positive clutch shown, which can be disengaged when it is desired to use a hand worm feed.

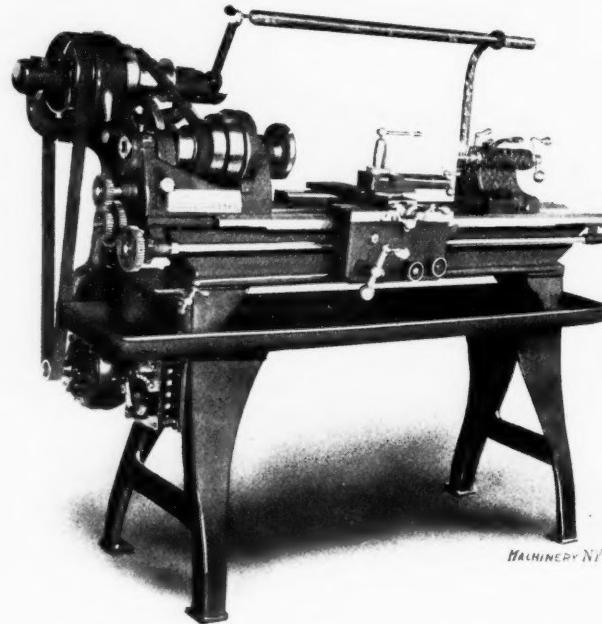
The head is firmly gibbed on the radial arm, and may be adjusted in and out by rack and pinion actuated by a hand-wheel. It is locked in position by clamp screw and lever *U*. It will be noted that, in accordance with their usual practice, the builders have enclosed all the gearing, thereby protecting both the operator and the mechanism from injury. This construction also minimizes the number of bolted-on bearings, and gives a pleasing appearance of neatness and simplicity to the design.

This machine will be furnished with a square, round, plain swiveling, worm swiveling, round tilting, square box or square

tilting table. The square box form of table is shown in the illustration.

SENECA FALLS MOTOR DRIVE FOR "STAR" LATHES

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has recently brought out a new type of motor drive for its 9- and 11-inch "Star" lathes. This new arrangement is shown in the accompanying illustration. The advantage of this type of motor drive over other methods employed is in its adaptability to the varying conditions imposed by the users of small engine lathes, as they ask for motors for all kinds of electric current. For this reason the drive has been designed so as to use any kind of constant or variable speed motor. Preferably, it should be non-reversible, and with a speed of 1,000 to 2,000 revolutions per minute. This drive may be easily attached to a lathe. A pulley on the motor of the proper size transmits the power by belt to a countershaft pulley that runs constantly in one direction. A belt is also used to transmit motion from the countershaft to the lathe spindle. Means are provided for quickly tightening these belts so that they can be kept at the proper tension until worn out, without shortening them. Experience has proved that this method of driving small lathes has advantages over rigid gearing and chain belt drives, as the use of belts will often prevent damage to both motor and lathe. Starting, stopping, and reversing the rotation of the lathe spindle is controlled by a shifting bar placed horizontally above the lathe within easy reach of the operator. When this bar is in the central position, the lathe is stationary. By shifting it to the left, a forward motion is imparted to the lathe spindle, while shifting it to the right gives a reverse movement.



Small Lathe equipped with the New Seneca Falls Motor Drive

The driving mechanism consists of friction clutches and gears for reversing the motion, which are encased and run in a bath of oil. This mechanism is simple in its construction and it is not liable to damage or disarrangement. The bearings are thoroughly lubricated by oil rings.

LELAND SENSITIVE MULTI-SPINDLE DRILL

The accompanying half-tone illustrations show a front and rear view of a four-spindle sensitive drill press built by W. H. Leland & Co., Worcester, Mass. This machine is known as the Leland "sensible" sensitive drill press, and in its design several new and interesting features have been introduced. Chief among these features are the arrangement for obtaining proper belt tension, the variable lever ratchet feed for the spindle, the arrangement of positive spindle stops, and the general design of the frame and the table, which makes it possible to obtain the maximum of strength without giving the machine a clumsy or unattractive appearance. The ma-

chine, however, is very heavy in comparison with the general type of these machines, it being about 250 pounds heavier than some other machines of its class. This additional metal has been distributed with care, so as to put it in such places where it will render the machine more efficient.

As will be seen in Fig. 2, the machine is provided with loose and fast pulley drive for the main driving shaft in the rear. The loose pulley is made smaller than the tight, to relieve the tension on the belt when the machine is not running. On the main driving shaft are placed the four-step cone pulleys from which the power is transmitted to the upper horizontal driving shafts and from there in the usual manner to the vertical spindles. The arrangement for obtaining the proper belt tension on the vertical belts between the cone pulleys as well as on the horizontal belts from the pulleys which drive the vertical spindles, is of especial interest. As shown in Fig. 2 the frame, or, as it has been commonly called, the "goose-neck," of the individual drills, is of a trian-

for the cone and driving pulleys are directly connected with the screw, they will consequently move outward or inward, as the case may be. Owing to the fact that the thrust on the screw is taken in a direction such that the axis of the screw bisects the angle between the vertical and horizontal belt pulls, the tension on both of the belts will adjust itself automatically so that it will be of the same amount in each, this being possible on account of the socket joint in the main column which takes the thrust. When the bearings have taken their proper location, the bracket carrying them is clamped in position in the slot in the back of the frame, by means of the handle already referred to. This means for tightening the belts is both convenient and efficient. It is quickly operated and it equalizes the tension on both belts automatically. When small holes are drilled and less belt tension is required, the belts may be slackened. When heavier drilling is to be done, it is but a moment's work to again get heavier tension on the belts.

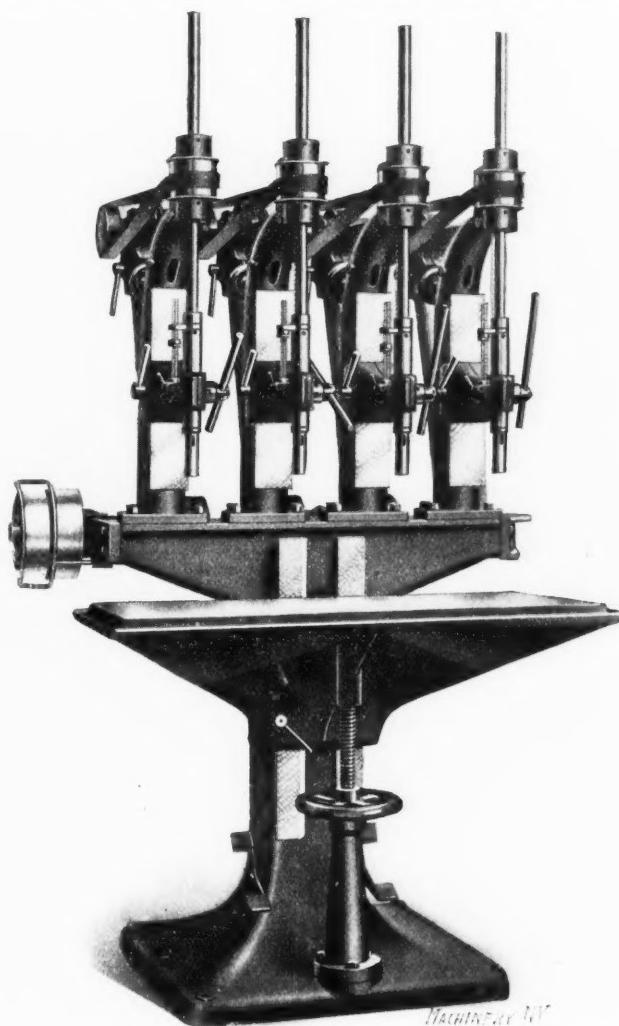


Fig. 1. Sensitive Four-spindle Drill, built by W. H. Leland & Co., Worcester, Mass.

gular construction, that is, it is provided with two braces in the back so placed that the belt tension from the two belts will largely strain these braces as compression members, thus insuring the maximum strength.

At the back where these two braces join, the frame is provided with a slot, the sides of which may be brought together or tightened by means of the handle shown in Fig. 2, immediately below the pulley transmitting power to the vertical spindle. The bearings for the upper cone pulleys and the pulley driving the spindle are held in this slot, and are supported by a screw which enters into an elongated nut provided with a hand-wheel, as shown, between the two braces. The end of the elongated nut rests in a socket in the back of the main column of the frame or goose-neck. When the binding handle mentioned is loosened and the hand-wheel operated, the screw is moved either out or in, according to the direction of rotation of the wheel, and as the bearings

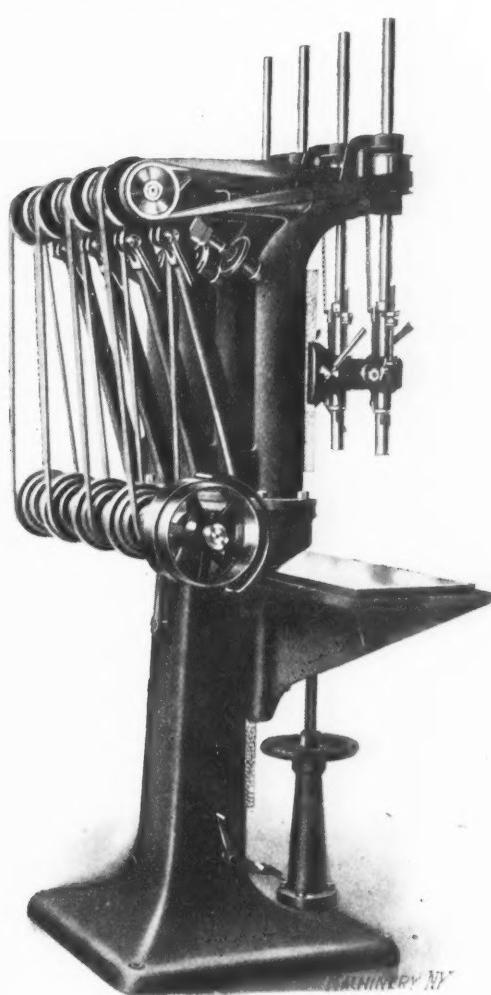


Fig. 2. Rear View of Leland Sensitive Drill, showing Driving Arrangement

The main driving shaft is provided with a bearing in the center, as well as at each end, in order to maintain perfect alignment; and at the top of the spindle, a bearing is provided at each end of the spindle pulley. It will be seen in Fig. 1 that apparently the pulley on the vertical spindle is wider than necessary. As a matter of fact, this pulley is actually a drum, and the extra width is required on account of the swinging action of the driving pulley when adjusted for belt tension. The width of the belts used is $1\frac{1}{4}$ inch, but the spindle pulley is more than twice the width of the belt. This permits the belt to assume a normal position on the pulley when the shaft in the back is moved either up or down, as required.

The machine is built in two styles, one having all ball-bearings, while the other is provided with bearings with inserted bushings, these latter being made of Parsons white brass. All the bearings on the machine when provided with inserted

bushings are ring-oiled with the exception of the vertical bearings, which are equipped with felt storage for the oil. The bushing bearings are superior in many respects to the usual plain babbitt bearings. When ball-bearings are used, the belts, of course, run in oil and the bearings are dust-proof.

The base of the machine is of a box-shaped section and the top of the base onto which the individual drill frames are bolted is also made of a box section, which maintains the truth of the surface onto which the frames are bolted, a feature which is highly important if accuracy is expected. The table of the machine is heavily ribbed on the under side in a manner very similar to that of a surface plate; this is indicated both in Figs. 1 and 2. This method of ribbing is very necessary on a machine of this type, where accurate work is to be performed. Often the tables of sensitive drill presses are not strong enough to carry the heavy weight of the work with its drill jig, when placed on one corner of the table, without springing to some extent, and in such cases it is, of course, impossible to drill a hole that is at right angles to the base surface of the work. The table is raised and lowered by an elevating screw which is stationary and engages with a revolving nut hand-wheel, the thrust being taken by a ball-bearing. It is not necessary to cut a hole in the floor in order to get the extreme range of the vertical movement of the table. A groove is provided around the edge of the table for oil or other drilling compound.

It will be seen in Fig. 1 that a foot-treadle is provided on both sides of the machine, so that the shipper may be operated by the foot from either side, according to the position of the operator. A locking arrangement consisting of a latch which holds the shipper positively in position when once operated, is provided. This locking arrangement, however, does not prevent the shipper from returning to its original position when the foot-treadle is again pressed, but it locks it in the position to which it has been brought by the last operation of the shipper treadle.

The sliding head is held at any desired position on the face of the column by a binder on the side of the head. An interesting feature in the design of the head is the ratchet feed employed. The feed is by a lever, as usual, which is of sufficient diameter and length to allow of heavy feeds for large drills. By means of a slight twist of the handle, the ratchet pawl is brought out of engagement with any one groove in the ratchet collar, and brought into engagement with the next groove, the engagement being positive as long as there is no twisting action on the handle. This design is very simple, but handy and efficient. The lever can be moved quickly from a short to a long leverage, and can be locked, if required, in any position, but the tension on the spring employed in the ratchet feed device provides enough pressure to ordinarily hold it in any position. The lever is knurled on the end sufficiently to get a good grip.

On the side of the spindle a positive stop arrangement is provided. This device is made in two styles. The regular style consists of a screw provided with two nuts, one of which acts as a check nut binding the other on the screw on which they are both mounted. The nuts abut against a projection of the head when the spindle is brought down. This stop is positive and can be adjusted for very fine differences in measurements when required. It is set, of course, by means of a scale or standard measuring blocks. The special type of stop consists of a micrometer stop arrangement which makes it possible to take actual measurements directly, without the use of a scale. The screw on which the stop nuts are mounted has, in this case, been milled away nearly to its center, and on the flat surface thus provided a scale is graduated, on one side of the center line in tenths, and on the other side in fourths, of an inch. A graduated micrometer collar is then provided on the screw, by means of which it is

possible to take any measurements varying by thousandths of an inch. The micrometer screw is adjustable in its end bearings, so that it can be brought up or down as required, in order that readings for different depths of drilled holes may be made to start at zero. The thread of the micrometer screw is a ratchet thread being made like a square thread on one side, and with an angle on the other. As the square side of the thread takes the thrust, this makes a very strong, positive and durable stop.

The machine is furnished with from one to four spindles, as required, and it will drive to their full capacity, high-speed drills up to 29/32 inch in diameter, these drill sizes regularly having a No. 2 Morse taper shank, the spindle being provided with a No. 2 Morse taper socket.

The general dimensions of the machine are as follows: The distance from the face of the column to the center of the spindles is 7 inches and the distance between the spindles 9 inches. The maximum distance from the lower spindle end to the table is 24 inches, and it is possible to bring the spindle clear down to the table. The vertical adjustment of the spindle head is 11 inches, and that of the table 12 inches; the vertical feed of the spindle is 5 inches. The diameter of the spindle pulley is 4 inches. The working surface of the table for the 4-spindle machine is 11 x 41 inches, the outside of the table being 14 x 44 inches. The tables of the one-, two- and three-spindle machines are, of course, proportionally smaller. The diameter of the main driving pulley is 8 inches

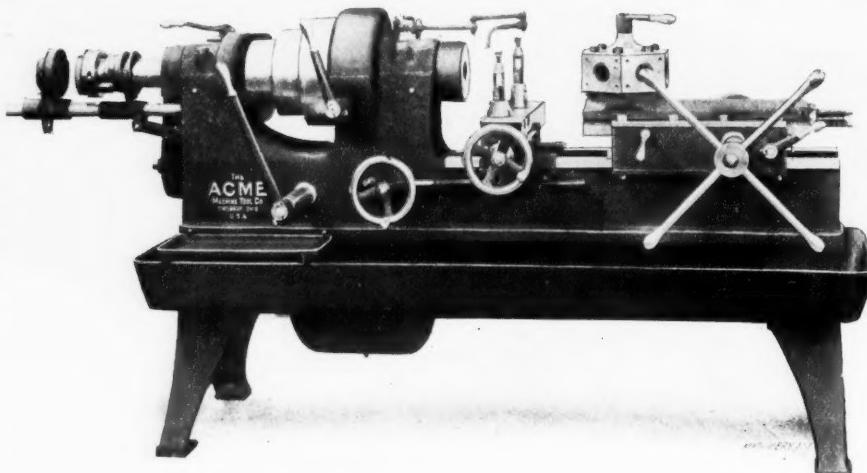


Fig. 1. The Acme Turret Lathe

and its face 2½ inches for the four-spindle machine. The floor space required for the same machine is 33 x 48 inches and the weight is 1,230 pounds.

THE ACME TURRET LATHE

The turret lathe or screw machine herewith illustrated and described is the product of a new firm, the Acme Machine Tool Co., of Cincinnati, O. The machine gives evidence on the first inspection of having been designed to meet the demand for a high grade, powerful tool, for use with high-speed steel. This is evidenced, for instance, by the fact that the head-stock is cast solid with the bed, and by the provision of a wide-faced, three-step cone with a friction clutch back-gear drive. The clutches are so arranged that the spindle can be stopped by throwing the operating lever to the middle position. The deep chip pan should also be noted. This will hold a liberal quantity of chips and oil, making it unnecessary to be constantly cleaning it out when taking rapid reduction cuts on steel.

The spindle runs in ring oiling babbitt bearings of ample size. The end thrust is taken at the front bearing, thus avoiding danger of binding or loosening from the unequal expansion of the steel spindle and the cast iron bed. The automatic chuck is forged solid on the end of the spindle, reducing the overhang, and supporting the collet firmly at its extreme outer end. A master collet is furnished with each machine, together with one set of bushings for stock of the largest capacity of the spindle. The chuck and stock-

feeding lever is placed within easy reach of the operator. Special attention has, in fact, been given to the location of all the hand wheels, levers, etc., to permit easy manipulation without requiring the operator to shift his position.

Interesting details of the turret slide mechanism are shown in Figs. 3 and 4. The turret A is hexagonal in form and is provided with tapped holes for attaching tools to the face, in addition to the regular holes with the binder bushings. A hole of the same diameter as those in the turret is bored through the turret stem B, thus allowing long work to be turned with short stiff tools. The tool clearance over the top of the slide is made extra large to permit the use of large dies and turret tools, while the slide itself is made wide to give rigidity to the turret and tools. This will be seen in Fig. 4.

Taper gibs C and C, also shown in Fig. 4, adjust the slide horizontally, while the slide bed has interposed between it and the top of the bed, the taper shim D, which by means of screws E, E, can be adjusted forward or back so as to raise or lower the turret. These two adjustments, working in combination, serve to preserve the alignment of the turret holes with the spindle. An interesting point in the construc-

The neck of the turret contains a bronze sleeve F, which is keyed to it, and thus revolves with it. This is bored taper to form a seat for the binding bolt B. By adjusting nut G, the turret may be held to its seat with any desired degree

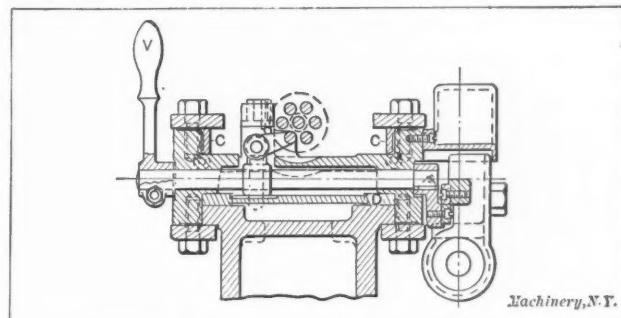


Fig. 4. The Feed and Automatic Stop Motions

of freedom, irrespective of the action of the regular clamp handle.

The turret revolving mechanism is shown most plainly in the lower view of Fig. 3. As the turret slide nears the limit of its backward movement, the roller on the end of lock bolt lever J runs up the incline of tumbler K, thus withdrawing the turret lock bolt L against the pressure of spring M. When L has been withdrawn, pawl N engages one of six hardened pins O driven into the neck of the turret (see upper view) and thus revolves the latter. At the conclusion of the indexing at the extreme end of the stroke, the roller at the end of J runs off the back side of tumbler K, locking the turret in position again. As the slide comes forward for its next cut, the tumbler K tips down out of the way of J, and pawl N snaps in back of the next pin O, both being thus in position to index again on the next return movement.

Details of the turret feed mechanism are shown in both Figs. 3

and 4. An independent stop is provided for each face of the turret. Bushing F, already mentioned, has bevel gear teeth cut on it meshing with a corresponding bevel gear P, which, by means of the shaft to which it is pinned, revolves the stop cylinder Q. This latter carries a series of six stop screws R, which are thus brought successively into position in line with the stop screw abutment S. The striking of the stop screw against this abutment first throws out the automatic feed (if it is engaged), and then brings up against a positive stop immediately afterwards. This permits using the automatic feed in turning up to a shoulder, which may then be finished by hand, allowing the cut to run out until the face has been smoothed up. The abutment S is pinned to a rod T, carrying a collar engaging the trip U, by means of which the power feed is thrown out. Lever V is used for throwing the feed out or in by hand. Also pinned to T is the handle W, which permits abutment S to be swung around out of the way of the stop screws, so as to feed beyond the positive stop, should occasion so require.

The power feed is driven positively from the spindle by gearing enclosed in the case shown at the right of Fig. 2. This gearing provides four changes of feed, controlled by a handle extending over the rear head-stock bearing. This power feed may be attached to the machine after it is purchased, if desired by the user, without additional machining.

The cross-slide is provided with a large graduated dial and positive stops. It has a hand longitudinal adjustment by means of the hand-wheel, bevel gears and screw shown on the front of the bed. This screw runs in a bronze nut screwed to the flat gib of the cross-slide, and is protected from chips and dirt by means of steel tubing. Power feed will be supplied for this cut-off if desired.

A double taper friction countershaft of improved design is

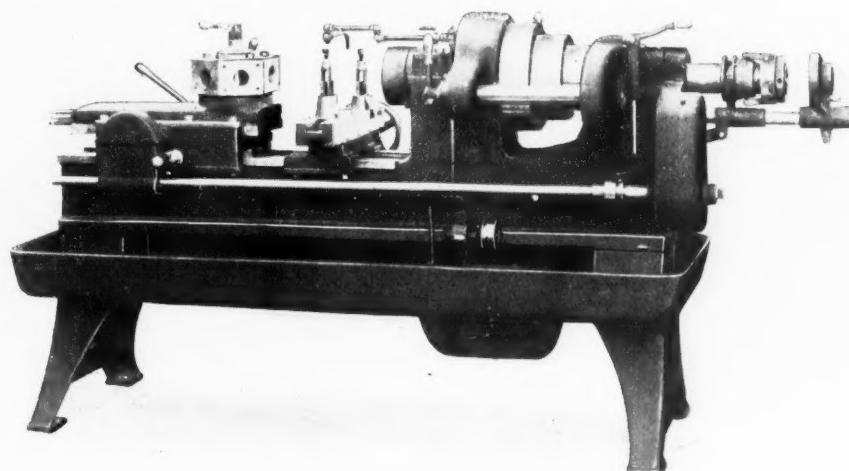


Fig. 2. Rear View of Machine, showing Feed Mechanism

tion of the taper shim D will be noticed in Fig. 3. The points of screws E bear on inclined surfaces, so that when

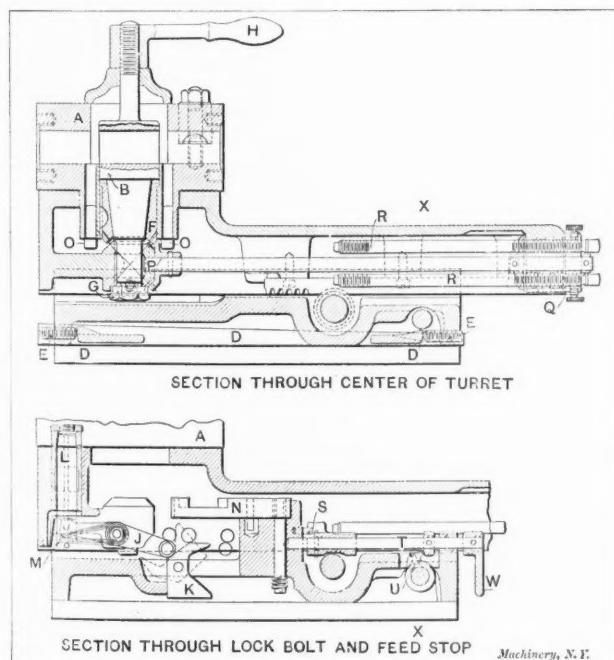


Fig. 3. Longitudinal Sections, showing Turret Indexing and Feed Mechanisms

the turret slide bed is raised from the bed of the machine, shim D goes with it, being held without danger of dropping loose.

supplied. The construction of the clutch is shown in Fig. 5. The shaft A_1 has keyed to it the driving sleeve B_1 . Interlocking with projections on this sleeve, but free to slide on the shaft, is a friction clutch C_1 . Bearing sleeve D_1 is a sliding fit in the hub of pulley E_1 and revolves on driving sleeve B_1 . It is provided with a large oil chamber holding enough lubricant to run a month or more without refilling. When thimble J_1 is pressed toward the left, levers K_1 , of which one only is shown, operate to engage the friction surfaces of E_1 and C_1 in a perfectly obvious manner. Ample adjustment for wear is provided by loosening screw H_1 and turning nut F_1 to bring

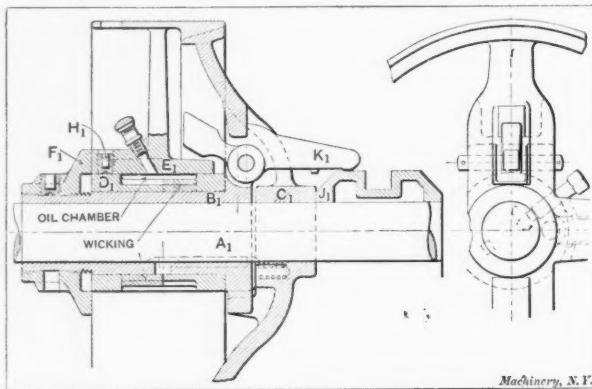


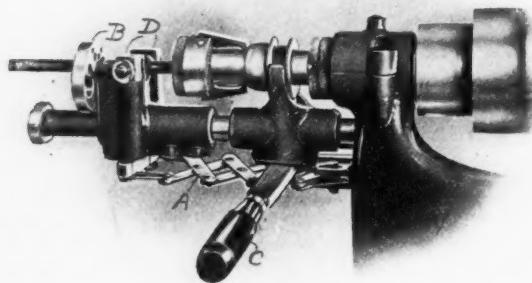
Fig. 5. Detail of Countershaft Clutch Construction

the pulley into closer engagement with the cone surface of C_1 . This construction will be appreciated by mechanics who have had to dismantle the counter-shaft and face of the hub of the pulley, in order to get more adjustment.

The machine illustrated is provided with chuck and stock feed, and power feed for the turret slide. It may be purchased without these attachments, however, either of which may be added at a later time without requiring any further machine work on the lathe. The same is true of a power feed to the cut-off slide, which will also be provided for work which requires it.

WELLS IMPROVED WIRE FEED

The accompanying illustration shows an improvement which has been introduced on the hand screw machine made by the F. E. Wells & Son Co., Greenfield, Mass. The advantage of this wire feed is that a single lever movement takes care of all operations and movements of the various parts necessary, including the opening of the chuck, the feeding of the stock forward, and the closing of the chuck. It is not necessary



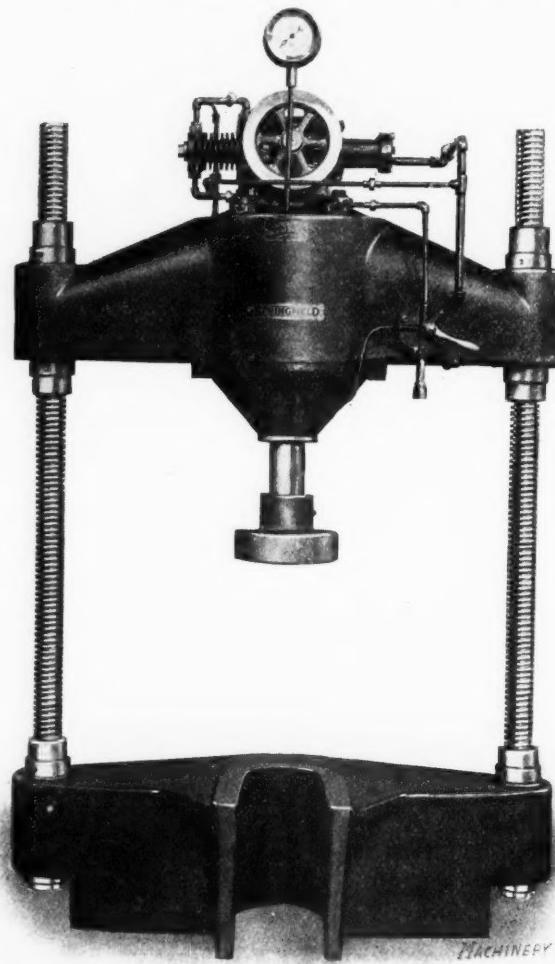
Improved Wire Feed Mechanism, made by the F. E. Wells & Son Co., Greenfield, Mass.

to fasten a dog, collar, or other device to the stock, as is the case with the ordinary type of wire feed. The operation of the device is briefly as follows: When the lever C is pulled forward, the two fingers D , which are provided with cam surfaces on their inner faces, are given a slight turn so that they grip the stock between them. By means of the pantograph, or "Jacob's ladder" arrangement shown at A , the bracket holding the fingers D is made to move through a distance very much greater than that of the movement of the lever C , so that a considerable length of stock may be fed in by a comparatively short movement of the feed lever. When the

lever C is moved back after the stock has been pulled forward, the fingers are again opened and are ready to take a new hold on the stock as soon as the handle C is again operated forward. At the same time that the fingers are released and moved back, the bracket immediately above the handle C , which is provided with a yoke engaging with the chuck closing collar, is moved backward, and the chuck is closed, so that thus all the operations of feeding the stock forward and the opening and closing of the chuck are accomplished by a slight movement of a single lever, without any additional manipulation. The disk shown at B is a guide for the stock and can be adjusted for different diameters.

SPRINGFIELD PNEUMATIC PRESS

The illustration shows an ingenious press for shop use made by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O. It is intended for general shop use in the insertion and removal of heavy arbors, and in making the press fits met



Pneumatic Press with Automatic Intensifier

with in machine building. It is an improved design of the machine shown in the department of New Machinery and Tools of the August, 1908, number of MACHINERY.

This machine operates by air pressure, either direct or intensified, as will be described. It consists primarily of two heavy frame castings, upper and lower, held together by the strong screws shown on each side. The construction of the lower base permits a large wheel up to 38½ inches in diameter to be placed between the screws. The opening permits the work to be pushed into place instead of being lifted off as would often be necessary if a circular opening only were provided. The two upright screws support the upper frame on the nuts shown. These are adjustable so that the upper frame can be lowered or raised to agree with the height of work being operated upon.

As stated, the press is operated pneumatically. The piston is 15 inches in diameter with a stroke of 8 inches. With an initial pressure of 80 pounds this gives a pressure on the work of 7 tons when direct air pressure is being used. For work

requiring a greater effort, the automatic pump mechanism, shown mounted on the top of the upper frame, is used. This is, in effect, a compressed air engine driving an air compressor capable of giving a maximum pressure of 225 pounds against the 15-inch piston, giving a pressure on the work of about 20 tons.

All the movements of the press are controlled by the valve shown at the right-hand side of the upper frame. In one

ing machine does to an upright drill press. The illustration shows the machine, which consists merely of an arm which can be mounted in any convenient manner, for example, on a post or on the wall of the building in which the machine is used. The working parts of the machine are mounted on the arm which is provided with a joint at about one-half of the distance of the spindle from the wall. The arm is of such proportions that the screw-driving spindle can be brought to a maximum distance of 7 feet from the post, and owing to the jointed construction, the arm may be swung around so that the spindle can be placed in any position within the circumference of a 14-foot diameter circle, except for a small area close to the post.

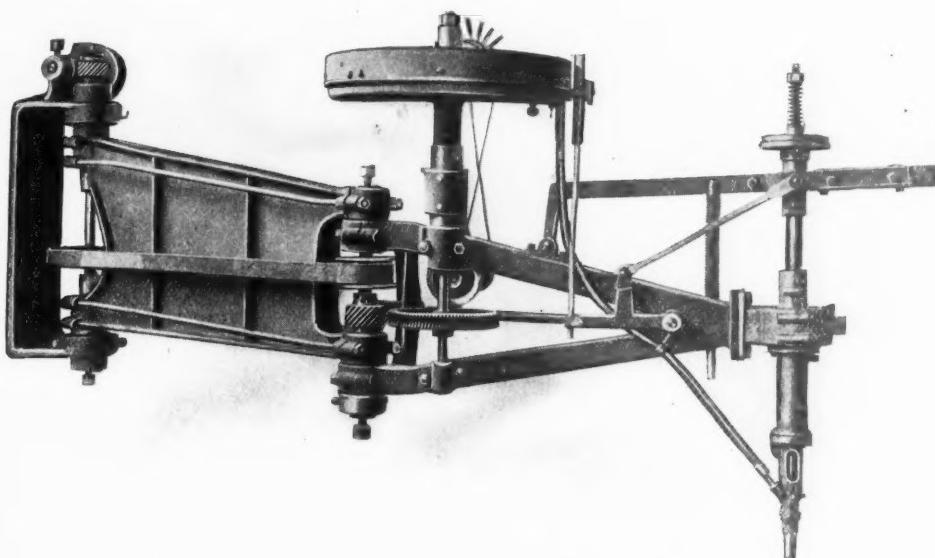
The spindle of the machine is spring counterbalanced so that it is automatically raised as soon as the operating lever is released. In operation, the screws are simply thrown into the pan or hopper shown at the top in the illustration. The work is then placed in such a position that the spindle end can reach the place where it is desired to drive the screw. The operator holds the feed lever in one hand and places the other on the head of the machine so as

to be able to swing it quickly into the desired position. He then depresses the lever as soon as the spindle comes in the desired position, thereby starting the screw. The spindle runs at about 800 revolutions per minute, so that the screws are driven in place practically instantly. The size of the machine shown in the half-tone is capable of driving screws up to No. 20, 4 inches long. The magazine, the friction-driven spindle, chuck, hopper, etc., are of the same design as that successfully used in the stationary type of machine previously described.

The machine is built to deliver, if necessary, 3 horse-power to the spindle, thus providing ample power for the largest screw within its capacity. It may be driven either from the line-shaft, counter-shaft, or by individual motor.

REYNOLDS RADIAL SCREW DRIVING MACHINE

In the January, 1909, issue of MACHINERY an automatic screw driving machine built by the Reynolds Machinery Co., Moline, Ill., was illustrated and described. The accompanying illustration shows another machine built by this company.



Radial Automatic Screw Driving Machine, built by Reynolds Machinery Co., Moline, Ill.

position of this handle, the piston is raised, and in the next position the initial air pressure is admitted above the cylinder. Should this not be sufficient to drive the work together, the handle is moved to the third position, which automatically starts the pump, gradually increasing the pressure to the desired point. A gage is furnished so that the operator may know at all times what pressure is being applied to the work.

The distance between the upright screws is 38½ inches. The maximum distance of the plunger at its topmost position to the bottom of the base is 42 inches. The machine requires a floor space of 24 by 48 inches.

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NEWTON CYLINDER BORING MACHINE

A new design of cylinder boring machine, which has been adopted as a standard by its builder, the Newton Machine Tool Works, Inc., Philadelphia, Pa., is shown in the accom-

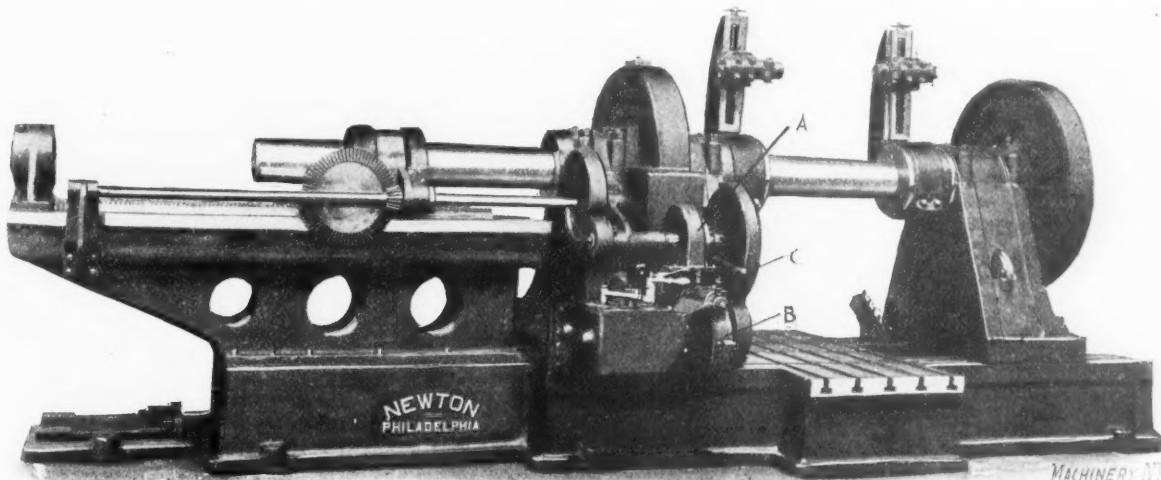


Fig. 1. Front View of the Latest Design of Newton Cylinder Boring Machine

which is the latest addition to the line of screw driving machines manufactured by the firm. This machine covers a range of work for which the regular stationary type shown with the previous description is not available, and bears the same relation to the regular or upright type as a radial drill-

panying engravings. This machine, as is evident after an examination of the illustrations, is exceptionally massive. The spindle is 8 inches in diameter and its bearings, both in the driving head and outer support, are amply large to insure rigidity and a minimum of wear. The particular machine

illustrated is intended to be driven by a variable speed motor which will be belted to the single driving pulley shown at the rear of the machine in Fig. 2. From the shaft on which this pulley is mounted, the motion is transmitted by spur gears to a driving worm meshing with a large worm-wheel which is mounted on a sleeve that revolves in bearings at each end of the head. This sleeve, which is 33 inches in length, transmits the motion to the boring-bar. The driving worm is of hardened steel, while the worm-wheel is of cast iron with an outer ring of bronze. The worm is provided with roll thrust bearings, and it has a triple thread of 6-inch lead. The bearing

repair shops, and in manufacturing plants where light metal work is handled, as well as in all other places where there is a considerable amount of light drill press work. The arrangement of the drill is rather ingenious and novel. As shown in the illustration, the drill is mounted directly on the motor casing, the main driving shaft passing up through the inside of the column, and transmitting the power by means of a round belt on a three-step grooved pulley, a small idler being provided to furnish the required contact of the belt with the pulley, this being necessary on account of the short center distance between the two grooved pulleys. The

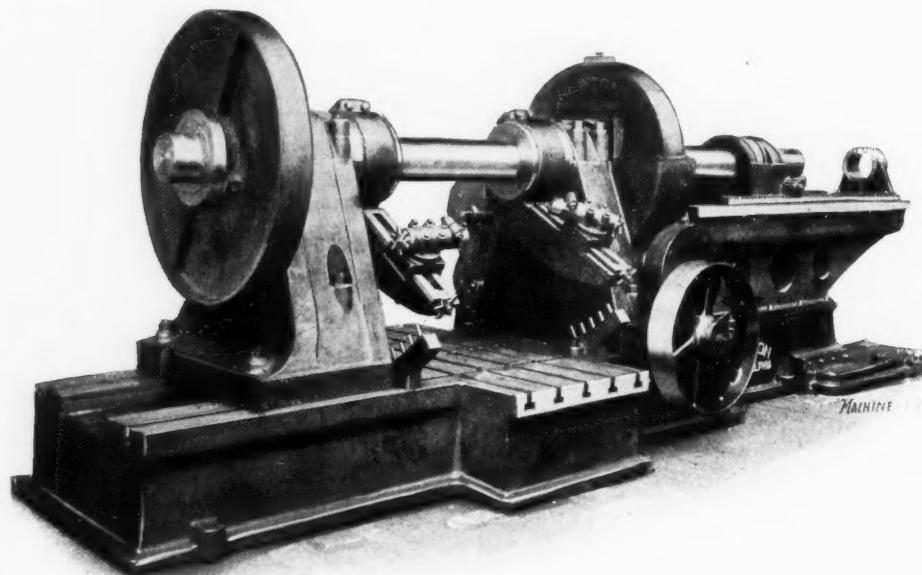
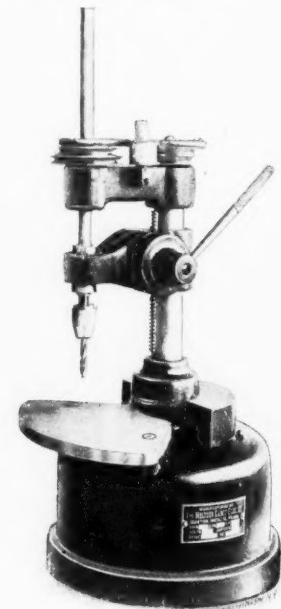


Fig. 2. Rear View of the Newton Cylinder Boring Machine

sleeve in the outboard head for supporting the end of the bar, is of large diameter and has a length of about 20 inches. The feed motion for the bar is transmitted from the end of the driving shaft to the worm-wheel *B*, which is mounted on the feed box shaft. From this shaft, through the different combinations of gears, nine changes of feed are obtained. A feed yoke which may be gripped to the bar at any point, and which is driven by pinions on either side of it meshing with racks mounted upon a supporting bed, serves to transmit the motion to the bar. This bed, as will be seen, is unusually rigid. For the fast traverse of the bar the worm shaft is connected with an idler male friction gear at *A*. The hand-lever *C* operates a friction clutch, controlling the fast traverse of the spindle and also the tooth clutch that engages the feed. With this design of drive and feed it is possible to obtain great variations in the spindle speed, although the present machine is arranged for from 3 to 9 revolutions per minute of the spindle, and for feeds ranging from 0.062 inch to 0.647 inch per revolution of the spindle. The length of the feed is 72 inches, and the distance from the center of the spindle to the top of the work table is 37½ inches. The facing arms are mounted on extensions of the spindle sleeves, permitting adjustments of the spindle without interfering with the arms. If desired, these arms can remain stationary while the spindle rotates. They are furnished with swiveling tool-holders which are mounted on a slide having a reversing power feed. This machine is furnished, when desired, with a counterbalance, as shown, to equalize the weight of the facing arms and to insure a steady even motion of the spindle when boring and facing at the same time. The machine has a capacity for boring cylinders up to 40 inches in diameter, and it will bore and face cylinders up to 50 inches in length. When motor-driven, the machine requires a 15-horse-power motor which should have, preferably, a 3 to 1 speed variation.

HOLTZER-CABOT UNIVERSAL DRILL

The accompanying illustration shows a small drill made by the Holtzer-Cabot Electric Co., 621 Albany St., Boston, Mass. This machine is intended for use in garages, machine and



A Small Drill Press of Novel Design

chuck will take drills up to 13/64 inch diameter. The tool is equipped with a ¼ horse-power motor and is arranged to drill at speeds varying from 800 to 2,700 revolutions per minute. Motors are supplied for any class of electric current supply.

* * *

NEW MACHINERY AND TOOLS NOTES

COMBINED PUNCH AND SHEAR: Covington Machine Co., Covington, Va. This is a punch and shear of the type in which the two machines are set back to back, with a common driving mechanism. The novelty of the design lies in the provision of sliding gears for giving a choice of either of two different speeds, depending on the service demanded.

HANDY DIE STOCK: Handy Mfg. Co., Bridgeport, Conn. This die-stock is intended to cut a wide range of sizes with one set of dies, and without requiring the use of special tools for adjustment. It is at the present made in four sizes—the smaller size with single and the larger with double end chasers, to give different pitches for different diameters of pipe.

SPEED INDICATOR WITH TIMING ATTACHMENT: Karl Weiss, 30 Woodlawn Terrace, Waterbury, Conn. This is a combination of watch movement and speed indicator, which automatically throws the worm gear out of mesh with the worm at the expiration of any desired time, up to three minutes. Its use makes the watch unnecessary when timing shafts and other rotating parts.

HAND PRESS: Standard Machinery Co., Providence, R. I. This machine is of the vertical slide type, with a cast iron frame mounted on a table with legs. The slide is cast in one piece and has attached to it a machine steel rack, operated by a pinion mounted on the lever shaft. It is adapted to fine work requiring more sensitive action than is obtainable with a hand-wheel or foot-treadle.

CENTRIFUGAL HOT AIR POLISHING AND DRYING MACHINE: Tolhurst Machine Works, Troy, N. Y. This machine is intended for cleaning small metal articles after electro-plating. It has been found that when such work is rotated at high speed in a centrifugal drier and subjected to a blast of hot air for 10 minutes or so, a high polish results. While the action is somewhat obscure, it is said to give unusually good results.

DRAFTSMEN'S SQUARE AND PROTRACTOR: D. J. Kelsey, New Haven, Conn. This protractor is similar in design to the maker's celluloid protractor, but is made of sheet steel. The edges of the tool are turned down to secure stiffness and to

prevent the contact of broad bearing surfaces of metal with the paper, and the consequent rubbing of dirt into the drawing. The swinging arm is graduated in 32nds of an inch. A vernier reading to 10 minutes is provided.

DOUBLE SPINDLE POLISHING AND BUFFING LATHE: Osborn Mfg. Co., Cleveland, O. This tool comprises two separate buffing and polishing spindles, mounted in a single frame, of light but very rigid construction. The shape of the front legs is such as to permit two men to work easily on the same machine without interfering with each other. The spindle drives are separate, so that the stopping of one spindle does not interfere with the other, while the advantages of the double machine in the matter of space economy are retained.

ADJUSTABLE DRILL JIG: G. R. Carlson, 367 Ellicott St., Buffalo, N. Y. This tool has a work-table 5 inches square, mounted on slides having screw adjustments in both horizontal directions, read by micrometer dials graduated to thousandths of an inch. A drill bushing is supported by a vertically-adjustable overhanging arm. The work-table is provided with slots for holding parallels or stops for locating the work. The device weighs about 15 pounds, and should be useful in work made in too small quantities to make a special jig profitable.

TWENTY-INCH DRILL: Aurora Tool Works, Aurora, Ind. This machine is an improvement over previous designs, the principal improvement consisting in increasing the strength and weight of the machine. It is built either plain or with back gears. The maximum distance between the spindle and the table at the base is 31 inches, and between the spindle and the regular drill table, 20 inches. The table has a traverse of 20 inches and the spindle a traverse of 7 inches. The machine requires one horse-power for its drive. The floor space occupied is 36 by 18 inches.

CALIBRATING APPARATUS FOR HIGH PRESSURE GAGES: Watson-Stillman Co., 192 Fulton St., New York City. This apparatus is designed for calibrating master gages or for comparing other gages with a master gage. In the first case the pressure is applied directly by weights acting on a piston in a carefully designed and fitted cylinder. Provision is made for eliminating friction effects and for controlling the pressure within fine limits, permitting accurate work in testing. In the second case the two gages are connected with a cylinder in which the pressure is produced by a hand-operated screw action.

TURBINE DYNAMOMETER: Herschell-Spillman Co., N. Tonawanda, N. Y. This is an absorption dynamometer in which the resistance is furnished by a turbine pump construction, discharging in a closed circuit through a by-pass. The by-pass may be throttled more or less to change the load imposed by the action of the blades on the water. The introduction of a small supply of fresh water serves to regulate the temperature and keep it below the boiling point. It is particularly adapted to automobile engine testing and will be furnished with a frame to fit the same testing stand in which the engines are mounted.

ADJUSTABLE BOLT AND CLAMPING DEVICE: Red Wing Adjustable Bolt Co., Red Wing, Minn. This adjustable bolt is intended for various temporary uses, but particularly for securing work to the tables of machine tools. It can be quickly shifted to vary the length, and is therefore of advantage in cases where it would otherwise be necessary to have a large assortment of different lengths of bolts for clamping. The bolts are provided with ratchet-shaped stops, on any one of which a clamp may be secured. Two bolts comprise a set, and by means of these and a U-clamp, work of a great variety may be clamped down.

BI-CENTRIC MASTER-KEYED PADLOCK: Yale & Towne Mfg. Co., 9 Murray St., New York City. This is a new design of padlock of the highest quality, embodying the makers "Bi-centric" system of master-keying. Separate plugs are provided for the master key and the operating key. When thus made, the locks may be arranged in any number of sets, each set controlled by a master key and all controlled by a grand master key. No two padlocks have keys alike, and the original simplicity and security of the pin-tumbler mechanism is not impaired. The locks can also be arranged as for safe deposit system, so that the use of two keys is required to operate the lock.

RONSON UNIVERSAL WRENCH: Cryder & Co., Park Ave. and 63rd St., New York City. This wrench, when closed is only 6 inches in length and weighs but 8 ounces, though it provides 9 wrenches in one, ranging in size from 3/16 to 13/16 inch. It consists in general of a set of four wrenches, held together by a screw and wing nut in the center. The wrenches are slotted so that any one of the four wrenches may be projected outside of the others, when it is to be used. When one of the wrenches is pulled out for use, the others form a handle, giving considerable leverage. The screw passing through the slot in the wrenches has a square body, making it impossible for the members to turn.

STOP MECHANISM FOR LATHE CROSS-SLIDE AND CARRIAGE MOVEMENTS; Lodge & Shipley Machine Tool Co., Cincinnati, O. In the July and August, 1909, numbers of *MACHINERY*, department of New Machinery and Tools, we described two

special forms of Lodge & Shipley lathes, in which an improved stop mechanism was incorporated as one of the principal features. The builders are now prepared to furnish their regular patent head lathes in the smaller sizes with this stop mechanism, giving such lathes many of the advantages of the turret machine in the matter of the duplication of diameters and shoulder lengths. With the use of these stops, a single tool may be used for turning or boring duplicate work of considerable complication.

AUTOMATIC TAPPING CHUCK: Pawtucket Tool Co., Inc., Pawtucket, R. I. Two styles of automatic tapping chucks, known as styles A and B Thompson chucks, have been brought out by this company. The style A chuck is intended for use in radial drills and the style B more especially for upright drills; the latter style contains its own reversing mechanism, while the other is employed on machines on which such mechanism is already incorporated. There are no projecting parts on these chucks. The advantages claimed for them are that they are simple in construction and require no tightening and loosening. Holes can be tapped clear to the bottom, and the breakage of taps is practically eliminated. The chuck stops automatically and instantaneously at the bottom of the hole.

RIVETING MACHINE: Charles Greiner Co., New Haven, Conn. The principal feature of this machine is its high speed; the machine will strike from 1,000 to 6,000 blows per minute when the treadle is depressed. The principal working element of the machine is a spring cushion hammer which works in a gun metal cylinder and which is actuated by the engagement of a roll at its upper end, with cam-like projections on the end of a flange which revolves on a horizontal plane and is driven by a friction clutch. In combination with the great number of blows per minute the hammer spins at a high rate of speed and causes the head of the rivet to be evenly spread. The elastic blow prevents injury to fine work and allows working of rivets at different heights without altering the adjustment.

HORIZONTAL, BORING, DRILLING AND MILLING MACHINE: Fosdick Machine Tool Co., Cincinnati, O. This machine, known as the style A, is a new design capable of performing all the operations of drilling, milling, tapping, boring, facing, etc., on light and heavy work, within the dimensional limits of the machine. It is of the type in which the spindle is mounted on a head, vertically adjustable on the face of a column, which is itself horizontally adjustable on the base of the machine. A particular feature of the design is the rugged construction of the slide mechanism for operating the boring bar feed. Special attention has also been given to placing the spindle-driving gears close to the work, so as to reduce to a minimum the torsional stress in the spindle. Power feed and quick-return movements are applied to the movement of the column on the base, and to the movement of the head on the column. Eight changes of positive feed are provided for these movements, as well as for the end motion of the spindle. There are sixteen spindle speeds, ranging from 4 to 216 revolutions per minute. The machine is built in two sizes. The No. 1 machine has a table 42 by 72 inches area, and the No. 2, 42 by 120 inches. An outboard support for the boring bar is provided, adjustable horizontally and vertically. The machine will also be furnished, if desired, with a constant or variable speed motor drive. All the gears are of steel and the bearings are all bronze bushed. Careful attention has been given to workmanship and design in all details throughout the machine.

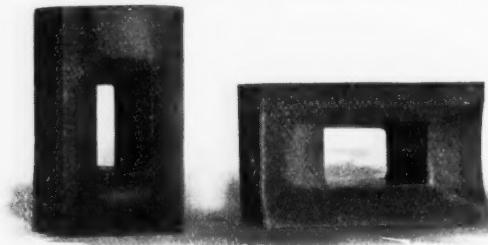
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VANADIUM FORGING DIES

The severity of the service imposed on riveters and forging dies, boiler punches and other tools in similar uses often makes the upkeep abnormally expensive even when the best carbon steel is used. It is in such trying situations that certain alloy steels have shown marked superiority—a superiority so great in fact as to be in some instances very noteworthy. For example, in a ship-building yard on certain severe work, pneumatic hammer riveting dies made of the best carbon steel obtainable and treated in approved manner lasted only about ten hours each. The vibrations crystallized the shanks of the dies, the result being breakage at the juncture of the shank and the die proper. When these carbon steel riveter dies were replaced by vanadium steel dies, their life was greatly extended, fourteen months' service being reported by one concern using this alloy for its pneumatic riveter dies. An article on the characteristics of vanadium steel referring to its marked superiority for severe service was published in the engineering edition of *MACHINERY*, October, 1907.

The accompanying illustration shows a pair of forging dies made of mild type H vanadium steel supplied by the American Vanadium Co., Frick Building, Pittsburgh, Pa., which are worthy of attention in this connection. In this case the best

carbon steel dies lasted only about two days when worked to the limit of capacity. The vanadium steel dies substituted have been in service for four months, and are still in good shape. The ratio of gain in endurance is already 60 to 1, and the prospect is that it will be much greater. Type H vanadium steel analyzes: carbon, 0.75; chromium, 0.90; vanadium (contained), 0.25; sulphur and phosphorus, very low. The amount of vanadium contained is small, being only about 1/400 of the total. It is evident, as has been before remarked, that vanadium has a very subtle and marked physie effect to make so great a change in characteristics of steel when administered in such small quantities. It seems to make a great improvement by its presence alone aside from its chemical combination.



Vanadium Forging Dies

tion. Vanadium acts as a deoxidizer, and counteracts the effect of fatigue and induced crystallization, the prime cause of failure of riveter dies, forging dies, and other dies and punches subjected to severe and often repeated shocks.

It is interesting to note that recent practice in making vanadium alloys tends toward the use of even smaller quantities of vanadium, particularly in iron castings. Where the practice several years ago ran about 0.25 per cent it is now found advisable to reduce the vanadium content to 0.12 or 0.10 per cent. Sometimes even smaller percentages are used with marked increase of tensile strength and elasticity.

* * *

In the account of MACHINERY's seventh annual outing in the November number it was stated that the Sandy Hook R. R. is the only railroad owned by the United States Government. This statement is an error. The Panama R. R. is also owned by the government; it was purchased with the Panama Canal.

* * *

PERSONALS

R. H. Victory, formerly of the Lowell Machine Shops, Lowell, Mass., is now assistant superintendent with the Eastern Bolt & Nut Co., Providence, R. I.

David Millington is now traveling in Europe introducing a new line of full and one-half automatic screw machines lately brought out by Ludwig Loewe & Co., Berlin, Germany.

Charles Flannigan has been made superintendent of the Fox Machine Co., Grand Rapids, Mich., succeeding Matthew Lund, who has been placed on the road as salesman for the company.

John W. Doyle, for fifty-two years an employee of the George W. Prentiss Wire Co., Holyoke, Mass., and for many years foreman of the fine wire department, has resigned on account of ill health.

Guy H. Gibbs, who has been with the Westinghouse Electric & Mfg. Co. for the past eight years, four of which have been with that company's Cincinnati office, is now with the Western Electric Co. at Cincinnati.

T. Commerford Martin, for many years editor of the *Electrical World*, has retired to become permanent secretary of the National Electric Light Association. Mr. Martin is writing the biography of Thomas A. Edison.

C. A. Koehler, for the past three years foreman of the wood pattern department of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned to become foreman of the wood pattern work of the Stevens-Duryea Co., Chicopee Falls, Mass.

Henry L. Barton, for several years works manager of the Westinghouse Machine Co., East Pittsburg, Pa., has left that company, and with others has formed a new company known as the Metal Products Co. which will manufacture automobile parts in Detroit, Mich.

Charles E. Meech, secretary of Wilmarth & Norman Co., Grand Rapids, Mich., who has been in charge of the company's Alaska-Yukon-Pacific exposition in Seattle, Wash., is now making an extended business trip in the interests of the company along the Pacific coast.

Holden I. Crane, for the past six years connected with the operating department of the Cincinnati Milling Machine Co., Cincinnati, Ohio, and Percy S. Crane, a well-known Cincinnati business man, have formed the Crane Machine Tool Co., and have taken over the sensitive drill business of the Knecht Bros. Co.

Francis Walker has been employed sixty-four years without a break in the Fairbanks Co.'s scale factory, St. Johnsbury, Vt., and for forty-nine years has been at the head of its foundry department. Col. Walker, as he is known in his home town, was eighty-four years old October 27, and, despite his age, he is at his post every day directing the work of 160 men.

A. P. Warner, vice-president of the Warner Instrument Co., Beloit, Wis., whose purchase of a Herring-Curtiss aeroplane was mentioned in the August number, has made a few successful trials on the Morgan farm near Beloit. The first flight was made November 2, when a height of about fifty feet was attained. Mr. Warner has an improved form of aeroplane in mind, and if his plans are successful it is possible that he will manufacture aeroplanes for sale.

OBITUARIES

Frank J. Ludington, an inventor of cigarette-making machinery, died at Waterbury October 2, aged sixty-three years.

Richard Watson Gilder, editor of the *Century* and a well-known author and poet, died suddenly of heart disease in New York, November 18, aged sixty-five.

George W. Hoffman, manufacturer of the U. S. metal polish, and other specialties, died at his home in Indianapolis, Ind., October 22, after a short illness. The business will be continued by his widow.

Joseph B. Bancroft, president of the Draper Co., Oakdale, Mass., manufacturers of cotton mill machinery, died at his home in Oakdale, October 25, aged eighty-eight. He succeeded Gen. William F. Draper as head of the Draper Co., two years ago.

Tatem Parsons, the first engineer of the locomotive *John Bull*, died at Camden, N. J., November 5, aged ninety years. He was the first engineer to handle the throttle. The famous locomotive is now in the National Museum at Washington, D. C.

Lemuel Coburn, president of the Coburn Trolley Track Co., Holyoke, Mass., died at his home in Holyoke, October 26, aged seventy-nine years. Mr. Coburn was the inventor of the Coburn trolley apparatus and of many other devices, among which was a successful rag cutter for paper mills. This rag-cutting machine first brought Mr. Coburn prominently before the mechanical world.

John Moffitt, inventor of the threshing machine, died recently in Denver, aged eighty-four years. Moffitt constructed his first threshing machine on his father's farm near Canton, Ohio, in 1851, to do away with the old flail method of threshing grain. It proved to be so great an advance that it brought him international fame. The new machine was exhibited at the world's fair in London in 1851 where it attracted the attention of royalty itself. Mr. Moffitt built and sold his thresher for several years and later became interested in the rubber business in Boston. Still later he went to California and engaged in mining, and developed a cheap and expeditious method of smelting; also improved mining machinery.

Edward D. Entwhistle, who in his youth was a fireman and engineer of George Stephenson's locomotive *Rocket*, died at his home in Des Moines, Iowa, November 1, in his ninety-fifth year. He was only sixteen when employed by Stephenson as fireman of the *Rocket* on its epoch-making trial trip from Manchester to Liverpool in 1831. After a few trips Stephenson turned the care of the locomotive over to Entwhistle, who made two trips daily over the first railroad for nearly three years. Mr. Entwhistle came to the United States, and in 1856 settled in Des Moines. He was first employed in the United States as engineer on the steamer *Troy* running on the Hudson River, and later was engineer of one of the lake steamers for several years. In Des Moines he was in charge of the engines of various large mills. He had a clear memory of his trial trip with Stephenson, and the enthusiasm of the crowds who witnessed it. He lived in Des Moines for fifty-three years.

Robert M. Van Arsdale, publisher of the *American Engineer and Railroad Journal*, died suddenly of apoplexy at his home in New York, November 23, aged sixty-one years. Mr. Van Arsdale was connected with trade journalism from his twenty-fifth year when he became associated with a high tariff paper in Chicago. In 1875 he joined the staff of the *Railroad Gazette* as advertising solicitor, and remained with that journal until he purchased the *National Car Builder* and began its publication in 1880, with James Gillett editor. In 1896 Mr. Van Arsdale purchased the *American Engineer and Railroad Journal* from M. N. Forney, who remained its editor for one year, when the two papers were combined under the name of *American Engineer, Car Builder and Railroad Journal*. Two

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years later the name was changed to the present title, *American Engineer and Railroad Journal*, G. M. Basford then being the editor, who was succeeded by R. V. Wright, the present editor, in 1905. Mr. Van Arsdale had a wide acquaintance among railway mechanical officials and manufacturers of railway supplies, and was a man highly esteemed by his friends and acquaintances. He is survived by his widow. The burial was in Chicago.

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COMING EVENTS

December 1-3.—Annual convention of the National Society for the Promotion of Industrial Education. An exhibition of school work from all over the United States will be one of the features. J. C. Monaghan, secretary, 29 West 44th St., New York.

December 6.—New York meeting of the American Society of Refrigerating Engineers. Secretary W. H. Ross, 154 Nassau St., N. Y.

December 7-10.—Thirtieth annual meeting of the American Society of Mechanical Engineers in the Engineering Societies Building, 29 West 39th St., New York. The professional papers assigned to the meeting are as follows: Tests on a Venturi Meter for Boiler Feed, Charles M. Allen; The Pitot Tube as Steam Meter, George F. Gebhardt; Efficiency Tests of Steam Nozzles, F. H. Sibley and T. S. Kemble; An Electric Gas Meter, C. C. Thomas; Tan Bark as a Boiler Fuel, David M. Myers; Cooling Towers for Steam and Gas Power Plants, J. R. Bibbins; Some Studies in Rolling Mill Engines, W. P. Cain; An Experience with Leaky Vertical Fire Tube Boilers and the Best Form of Longitudinal Joint for Boilers, F. W. Dean; Testing Suction Gas Producers with a Koerting Ejector, C. M. Garland and A. P. Kratz; Bituminous Gas Producer, J. R. Bibbins; The Bucyrus Locomotive Pile Driver, Walter Ferris; Line Shaft Efficiency, Mechanical and Economic, Henry Hess; Pump Valves and Valve Areas and a Report on Cast Iron Test Bars, A. F. Nagle. The social entertainment will be in charge of the members residing in and around New York, under the direction of a local committee, of which Mr. William D. Hoxie is chairman. A number of excursions are planned to points of interest, and a lecture for members and guests on agricultural machinery will be given in the evening of one of the meeting days.

December 8-10.—Annual meeting of the American Society of Chemical Engineers, Philadelphia, Pa. J. C. Olsen, secretary, Polytechnic Institute, Brooklyn, N. Y.

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers' tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 18-20.—Annual meeting of the American Society of Heating and Ventilating Engineers. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 19-20.—Annual meeting of American Society of Civil Engineers, New York. Charles W. Hunt, secretary, 220 West 57th St., New York.

June 1-August 31, 1910.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

SOCIETIES AND COLLEGES

TEACHERS' COLLEGE, COLUMBIA UNIVERSITY, New York, has planned a series of night courses by which young men who have first-rate technical ability in the wood-working and machinist's trades can prepare themselves for the profession of teaching in industrial schools. This course is being offered at night in the school in industrial arts, and covers mathematics, drafting, design, wood-working, machine shop work, industrial history and methods of teaching industrial arts. A three years' course of night work will enable an expert mechanic, otherwise qualified, to gain a diploma as teacher of industrial arts.

TECHNICAL PUBLICITY ASSOCIATION, New York, held its second fall meeting Thursday evening, November 11, at the National Arts Club, 14 Gramercy Park. The subject of the evening's discussion was the merits of special issues of technical and trade papers. The argument for the affirmative was opened by James H. McGraw, president of the McGraw Publishing Co. The question was debated pro and con with enthusiasm. The vote on the question was in the negative, it being the opinion of the majority that there is no valid reason for the publication of special numbers to celebrate birthday anniversaries, etc.

TECHNICAL PUBLICITY ASSOCIATION, of New York, held its first monthly meeting for 1909-10 Thursday evening, October 14, at its headquarters, 14 Gramercy Park. Mr. Charles S. Redfield, advertising manager of the Yale & Towne Mfg. Co., was toastmaster. George H. French, head of the advertising and sales department, delivered an address on the principles of advertising, of much general interest to advertisers and publicity managers. Howard M. Post, advertising manager of the Western Electric Co., told of plans for a systematic study of the direct results of trade paper advertising. The burden of Mr. French's talk was the psychology and psychological aspect of advertising copy.

BRITISH ASSOCIATION OF ENGINEERS, 17 Victoria St., Westminster, S.W., has instituted an employment register for the use of engineers seeking employment, the principal features of which are: No fee of any kind will be charged, the cost of the management being defrayed by the association with a view to the ultimate benefit of the profession; qualified engineers of all grades may have their names recorded, though in making the selection, preference, naturally, will be given to members of the society; only a few names of probable suitable candidates will be submitted for each vacancy, so as to facilitate the employer's choice; and effort will be made to get personal knowledge of the candidates with full details of their qualifications, etc. A. S. C. Ackerman is the secretary.

NEW BOOKS AND PAMPHLETS

FUEL TESTS WITH ILLINOIS COAL. By L. P. Breckenridge and Paul Diserens. 55 pages, 6 x 9 inches. Published by the Illinois Engineering Experiment Station, Urbana, Ill.

UTILIZATION OF FUEL IN LOCOMOTIVE PRACTICE. BULLETIN NO. 402. By W. F. M. Goss. 28 pages, 6 by 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

INCIDENTAL PROBLEMS IN GAS PRODUCER TESTS. BULLETIN NO. 393. By R. H. Fernald, C. D. Smith, J. K. Clement and H. A. Grine. 29 pages, 6 by 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

COMMERCIAL DEDUCTIONS FROM COMPARISON OF GASOLINE AND ALCOHOL TESTS ON INTERNAL COMBUSTION ENGINES.—Bulletin No. 392. By Robert M. Strong. 38 pages, 6 x 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

BULLETINS OF REVENUES AND EXPENSES OF STEAM ROADS IN THE UNITED STATES FOR APRIL, MAY AND JUNE, 1909. Published by the Interstate Commerce Commission, Washington, D. C.

These bulletins give the mileage of various railway systems and tables of revenues and expenses of railroad systems operating more than 500 miles of lines.

THE SLIDE RULE. By J. J. Clark. 62 pages, 4 1/4 x 6 1/4 inches. Published by the Technical Supply Co., Scranton, Pa. Price 60 cents.

This book on the Mannheim slide rule is a plain, simple, practical description of the instrument and its use. The principles of logarithms are explained and the methods of use of the rule in combined multiplication and division, locating the decimal point, principles of reciprocals, square and square roots, cubes and cube roots, and trigonometrical functions. The treatment of the slide rule is one that will be appreciated by many who have never been able to use it with facility or satisfaction. The description is prepared in the plain, understandable style characteristic of the work of Mr. Clark, who is manager of the textbook department of the International Text Book Co., and dean of the faculty of the International Correspondence Schools. The book is highly recommended to all in need of a practical treatise on the subject.

HANDY MAN'S WORKSHOP AND LABORATORY. By A. Russell Bond. 467 pages, 5 1/2 x 8 inches, 370 illustrations. Published by Munn & Co., Inc., New York. Price, \$2.

This book was compiled largely from contributions published in the *Scientific American*, and valuable suggestions received in response to the opening of the department devoted to the interests of the "handy man." It treats of fitting up a workshop, shop kinks, the soldering of metals, and the preparation of solders and soldering agents, the handy man in the factory, and the handy man's experimental laboratory, and the handy man's electrical laboratory, the handy man about the house, and model flying machines. It will be found of considerable interest and probable value by amateurs and other tinkerers who have a penchant for making models, model apparatus and repairing machinery. The book is an appropriate present for boys of mechanical tendencies and inventive ability.

CYRUS HALL McCormick—HIS LIFE AND WORK. By Herbert N. Casson. 264 pages, 5 1/4 x 8 inches. Published by A. C. McClurg & Co., Chicago, Ill.

In this book Mr. Casson has given an account of the life and activities of McCormick, the inventor of the reaper, in the same interesting style characterizing his books, "The Romance of the Steel" and "The Romance of the Reaper." The effect of the invention of harvesting machinery on the world's industrial activity is tremendous and can scarcely be over-estimated. The reaper made the work of one man as effective in harvesting grain as that of ten laborers before its advent. The harvesting machine has greatly increased the available food supply and is one of the great contributing causes of the advancement made in civilization and material comforts during the past sixty years. The book will be read with profit by all interested in the characteristics of a man who had the genius of the inventor combined with the capability of a remarkable business man.

Mechanical World ELECTRICAL POCKET BOOK FOR 1910. 271 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6 d. net.

This electric pocket book is a companion publication to the well-known Mechanical World Pocket Diary and Year Book. The Electrical Pocket Book is confined to data on electrical matters comprising electrical units, resistance, specific resistance, mechanical and electrical unit equivalents, magnetos, electric bells and bell currents, electric transmission of power, dynamos and motors, methods of distinguishing electrical energy, alternating current systems, alternating current generators, polyphase motors, machine driving by electric motors, horsepower required to drive machinery, starting switches, motor generators, rotary converters, transformers, care and management of dynamos and motors, balancers, boosters, accumulators, conductors, cables, house wiring, circuit breakers, testing circuits, electric measuring instruments, lamps and lighting, electric welding, etc.

PREVENTION OF INDUSTRIAL ACCIDENTS. By Frank E. Law and William Newell. 194 pages, 5 1/4 x 7 3/4 inches. Published by the Fidelity and Casualty Co., New York. Price, 25 cents.

The appalling frequency of industrial accidents has aroused general interest in ways and means of accident prevention. Aside from the humanitarian aspect of the matter, the financial loss alone is so great as to demand the attention of manufacturers, business men and all concerned in the prevention of accidents from a purely selfish motive. In 1908 \$22,392,072 was paid in premiums for liability insurance, which is an indication of the responsibility carried by the manufacturers and the burden imposed on industry as a whole by industrial accidents. The pamphlet discusses care on the part of employers and employees; safety devices; steam boilers; electrical apparatus; elevators; the factory; wood-working machinery, etc. It is thoroughly practical and will be found of general value by manufacturers and by employees in charge of apparatus likely to cause injury or death by accident.

THE STEAM ENGINE. By Charles H. Benjamin. 316 pages, 6 x 9 inches, 198 illustrations and diagrams. Published by the Technical Press, Brattleboro, Vt. Price, \$3.

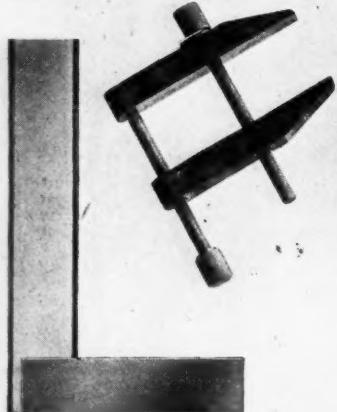
This treatise was prepared with the intention of covering practically the whole list of subjects relating to the steam engine, and is designed primarily for a text-book rather than a work of reference for engineers, although it will serve admirably for the latter purpose. The author explains the elementary principles of engines so that they may be readily understood by students. It pays much attention to practical problems, and questions in economy in operation are referred to the results of recent experiments made under working conditions. The contents of the work by chapters are as follows: Definition of terms, elementary principles, the simple steam engine, thermodynamics of air, thermodynamics of steam, valve and link motion, indicators and indicator diagrams, compound engines, conveyors, fly-wheels, steam in the cylinder, condensers, and heaters, piping and flow of steam, steam engine performance, steam engine design, specifications and costs. It closes with standard tables of weights of water, ammonia table and hyperbolic logarithms. The typographical excellence of the book is notable, the text, illustrations and press work being unequalled.

INDUSTRIAL TRAINING: TWENTY-SIXTH ANNUAL REPORT OF THE BUREAU OF LABOR STATISTICS. 394 pages, 5 1/2 x 8 3/4 inches. Published by the State Department of Labor, Albany, N. Y.

The report reviews the general conditions as to advancement in the manufacturing industries of New York State; the supply of skilled workers; the training of workers in industrial establishments; apprenticeship systems; attitude of employers and organized labor toward general industrial or preparatory schools; and attitude of organized labor toward trade schools. The summary of investigations is that the need of skilled male labor in the industries of the state is most severe in the manufacture of blown glass, many of the machinery and metal trades, manufacture of boots and shoes, and in certain of the building trades. It was found that the apprenticeship system in such industries as machine and building trades can be made more effective by introducing definite provision for systematic instruction. The need and value of general industrial and preparatory trade schools for boys and girls between fourteen and sixteen years is strongly testified by the report.

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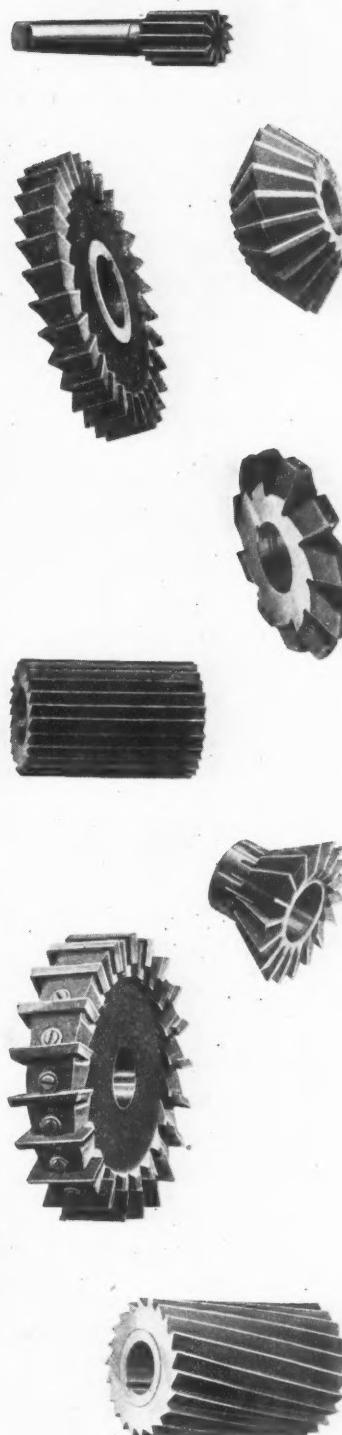
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of employers in all industries and is agreed to by the labor unions. Practical trade schools seem to be most in need in the machine and buildings trades. An extension of evening schools giving both practical and technical instruction in the trades is demanded by employers in a large proportion of the industries.

HAND BOOK FOR MECHANICS. By Franklin E. Smith. 328 pages, 5 x 7½ inches. Published by D. Van Nostrand Co., New York. Price \$1.50 net.

This book is intended for the general instruction of mechanics, particularly those who are weak in arithmetic. It treats of notation, addition, subtraction, multiplication, division, weights and measures, reduction of fractions, addition of fractions, arithmetical signs, subtraction of fractions, multiplication of fractions, division of fractions, decimal fractions, reduction of decimal fractions, addition of decimals, subtraction of decimals, multiplication of decimals, division of decimals, proportion, compound proportion, interest, involution and evolution, cube root. Part II treats of arithmetical signs and characters, and explains the solving of formulas. Part III is on mensuration and gives rules for finding the circumference, diameter and area of circles, area of ellipses, triangles, rhomboids, trapeziums, volume of solids including the sphere, cylinder, pyramid, cone and frustum. Part IV treats of weights, specific gravity, dimensions, measurements and weights of vessels, calculation of contents of tanks, cisterns, etc. Parts V and VI treat of the elements of simple machines, including the lever, pulley, wheel and axle, inclined plane, wedge and screw, and strength of materials. The work is one that can be recommended for the instruction of apprentices, mechanics and others who have not had the advantages of a good common school education, and it will also be found useful by those who desire to renew their knowledge of the things learned in youth and partly forgotten through disuse.

MECHANICAL DRAWING FOR TRADE SCHOOLS. By Charles C. Leeds. 122 pages, 8 x 11 inches. Published by D. Van Nostrand Co., New York. Price, \$2 net.

The author, who is assistant to the head of the school for apprentices and journeymen Carnegie Technical Schools, has presented a work on mechanical drawing that is a refreshing contrast to many of the books on the subject that have been published. It has been prepared with the idea of making students in mechanical drawing think and work without merely copying models. It is the outgrowth of his work in the Carnegie Technical Schools where the importance of developing the faculty of imagination and mental picturing an object was forcibly impressed on him. It is a faculty that many students lack, and the need for developing it became very apparent. The book in the beginning treats of the tools and elementary processes used in drawing, comprising pencils, pencil points, drawing board, T-square, triangles, drawing lines, laying off dimensions, use of compass and dividers, drawing circles and arcs tangent to lines, lettering, sketching, inking, etc. The plan of the work is that of displaying the drawing to be made on the right-hand page, giving the instructions for making the drawing on the left-hand page. A large number of practical examples are given, comprising the following: Flanged pin, machine bolt, clamp, sleeve, problems in projection, flanged pulley, 8-inch hand-wheel, lathe face-plate, positive clutch coupling, compression shaft coupling, safety flange coupling, geometrical problems, ellipses, spur gear, conic sections, intersections and developments, bevel gear, 12-inch speed lathe details, comprising the legs, bed, tool-rest, tail-stock and head-stock, examples of tabular data, bench grinding details comprising the frame, commutator bar, commutator ring, armature spider, generator frame, worm gearing, plate cam, periphery cam, conventional signs used in structural work, standard framing, beam connection, etc. The book is one that we can recommend to those who would learn mechanical drawing at home, and to the instructors in trade schools and other institutions requiring a good practical work on the subject.

ELEMENTS OF MACHINE DESIGN—PART I. By W. Cawthorne Unwin. 531 pages, 5½ by 8½ inches. 387 illustrations and diagrams. Published by Longmans, Green & Co., London and New York. Price \$2.50.

This well-known textbook on machine design was first published in 1877, and it since has been revised three times. In the revision of 1890 the chapters relating to steam engine details were published separately as Part II. Part I deals with general principles, strength of materials, rivets, bolts and other fastenings; journals and shafting; couplings; pedestals; transmission of power by gearing, belting, ropes and chains. In the present revision the work has been almost entirely rewritten, and the page size has been changed from 4½ by 6¾ to 5½ by 8½ inches. In the foreword the author writes of the great task of originally writing the book, and of the still greater task of keeping it abreast of the times, as follows: "It originally the author had fully realized the multiplicity and complexity of the problems which arise in designing machinery, the present treatise would probably not have been written. If he had now for the first time the task of writing it, he would no doubt take the view that for an adequate scientific treatment of the subject a much larger treatise would be necessary. . . . There are now so many aids to the study of the application of scientific principles to all branches of engineering practice and so much of engineering experience has been made accessible, that the difficulty of dealing with the subject at the time this book was written will hardly be recognized now. This treatise was intended to occupy a distinct field between works on applied science and empirical books of rules and collections of examples of machine details." The practical nature of Unwin's work has been generally recognized, and the machine designer using it will find that the present edition upholds the plan of the former editions and extends and improves it. One new chapter on keys and cotters has been added besides the general additions and changes in all other chapters. The index has been somewhat extended, but much room is yet left for improvement.

CATALOGUES AND CIRCULARS

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating and listing standard boring and facing tools for Gisholt lathes.

WASHBURN & GRANGER, 120 Liberty St., New York. Catalogue B of Dean dumping, shaking, and stationary boiler grates.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Copy of revised navy specifications covering electric motors and controlling devices.

HYDRO MFG. CO., Pittsburgh, Pa. Circular of "Hydro" recording and velocity gage for measuring the rate of flow of gases in pipe lines or ducts.

SCHUTTE & KOERTING CO., Philadelphia, Pa. Circulars of Koerting deep-well water jet pump and water jet eductors for mines, tunnels, etc.

E. C. ATKINS & CO., INC., Indianapolis, Ind. Circular illustrating and describing Atkins AAA car mover, being an improved form of pinch-bar.

COLLINS WIRELESS TELEPHONE CO., 54-56 Clinton St., Newark, N. J. Catalogue of wireless telephone sets for experimental, lecture, office and field purposes.

PEERLESS ELECTRIC CO., Warren, O. Booklet illustrating the use of Peerless motors on paper box machinery, blowers, pumps, envelope mailing machines, etc.

FOSDICK MACHINE TOOL CO., Cincinnati, Ohio. Circular of Nos. 1 and 2 Fosdick horizontal boring and milling machines of the elevating head type.

WALTON CO., Hartford, Conn. Circular of Walton extractor of broken taps. This extractor is made in 16 sizes, suitable for taps ¼ to 1½-inch diameter.

PIKE MFG. CO., Pike, N. H. Mailing card advertising Pike's "Little Four" sharpening set, reversible oil stone, "Koenig" razor hone and "Pykaro" knife sharpeners.

EMERSON ELECTRIC & MFG. CO., St. Louis, Mo. Bulletin No. 3309 replacing bulletin No. 3307 of electric forge blowers, direct connected for direct and alternating currents.

CRESCENT LAMP CO., 516-518 West Monroe St., Chicago, Ill. Circular of incandescent lamp guards, including the "Loxon," which is a guard that prevents theft as well as breakage.

NORTH BROS. MFG. CO., American St. and Lehigh Ave., Philadelphia, Pa. Circular illustrating and describing the "Yankee" breast drill with right- and left-hand ratchet movement.

AMERICAN BLOWER CO., Detroit, Mich. Sectional catalogue No. 250 of ABC blowers for cupolas, forges, melting and heating furnaces, forced draft, pneumatic tube systems, etc.

S. E. HORTON MACHINE CO., Windsor Locks, Conn. Price list of four-jaw independent reversible jaw chucks, made in seven sizes, covering the usual ratings of 8-inch to 26-inch sizes inclusive.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Treatise on Cochran feed water heaters and the profitable utilization of exhaust steam in condensing and non-condensing steam power plants.

F. W. DEVOE & C. T. RAYNOLDS CO., New York and Chicago. Catalogue of artists' and drawing materials, comprising colors, India inks, pencils, rubbers, pantographs, drawing instruments, T-squares, protractors, etc.

CELFOR TOOL CO., Buchanan, Mich. and 207 Railway Exchange, Chicago, Ill. Catalogue No. 10 of Celfor tools, reamers and three-flip drills, Rich flat drills, Celfor-Rich and quick-change chucks, reamer sockets, and grinding machinery.

SCHUMACHER & BOYE, Cincinnati, Ohio. Mailing folder illustrating S. & B. instantaneouse change gear engine lathes, built in 18-inch, 20-inch, 24-inch, 26-inch, 30-inch, 36-inch, and 48-inch sizes. Details of construction, including double-plate apron and head-stock, are also shown.

CAMERON ENGINEERING CO., 154-156 Berriman St., Brooklyn, N. Y. Circular on overhead tramways, trolleys, switches, cranes, and scales for overhead handling and weighing; a pulley block crane mounted on four truck wheels, made in five sizes, and having a capacity from ½ to 3 tons.

STROMBERG ELECTRIC MFG. CO., 108-128 North Jefferson St., Chicago, Ill. Descriptive circular of new wall type electric chronograph for registering the time of entrance and exit of employees, the time of starting and completion of jobs and other purposes where a time registering device is essential.

UNION STEAM PUMP CO., Battle Creek, Mich. Catalogue B of Union air compressors, comprising a complete line of various types and sizes in ordinary use for operating pneumatic tools, coal cutters, pumps, sand blast work, and for other purposes, in foundries, machine shops and manufacturing plants.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Pamphlet describing Cochran steam stacks and cut-out valve heater and receiver, and its application in connection with commercial systems of exhaust steam heating. The diagrams illustrating the installations of service are printed in colors.

CARBORUNDUM CO., Niagara Falls, N. Y. Vol. VII of the "Revised American Statesmen Series" on Benjamin Franklin, by F. W. Haskell, president of the Carborundum Co. The biography treats of the activities of B. Franklin in a brief but startling way, and we have no doubt that all readers of *MACHINERY* fortunate enough to receive one of these unique booklets will be much edified by the story.

GEORGE WESTINGHOUSE, Pittsburg, Pa. Pamphlet describing the Melville-Macalpine speed reducing gear for marine turbines; the 6,000 horse-power hydraulic absorption dynamometer used for testing the reducing gear at the works of the Westinghouse Machine Co., East Pittsburg, Pa., and report of tests of the reducing gear; also report of efficiency of high-speed steam turbines.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, O. Catalogue and stock list No. 3 of machines and small tools for the fabrication of iron and steel, comprising standard punches, coupling nuts, button head rivet snips (chrome-nickel alloy steel), twist drills, chisels, backcut punches, shear blades, punching machines, shears, I-beam punch, angle shears, bending rolls, rotary planers, wall radial drills, etc.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1181 of portable direct current ammeters and voltmeters. The characteristics of these instruments are accuracy and durability, though they are neither bulky nor heavy. They are operated on the D'Arsonval principle with a permanent magnet and moving coil. The magnetic structure is so arranged that the moving element can easily be taken out for repairs.

MAX VIEWEGER, 50 Church St., New York. Prospectus of the American Exposition to be held in Berlin, June, July and August, 1910, with diagram of floor space in exposition buildings Nos. 1 and 2. The prospectus gives the name of the American and German committees, which include such distinguished citizens as J. Pierpont Morgan, David R. Francis, John Wanamaker, Dr. George F. Kunz, Emil L. Boas, Dr. Nicholas Murray Butler, William G. McAdoo, C. A. Moore, etc.

NATIONAL-ACME MFG. CO., Cleveland, O. Circular illustrating the Acme automatic screw machine and samples of its work, also some interesting statistics. The company has a product department wherein 10,000,000 pounds of iron, steel and brass stock are annually cut into 100,000,000 parts. 3,000,000 screws and parts are carried in the New York store, 77 White St., 3,000,000 parts in the Chicago store, 56 West Washington St., and 15,000,000 in the Cleveland factory.

ARMSTRONG BROS. TOOL CO., 113 North Francisco Ave., Chicago, Ill. Catalogue and price list of Armstrong tool-holders, for turning, reaming, boring, slotting, drilling, cutting-off metals; and other machine shop specialties comprising lathe tool sets and cabinets, grinding holders, Armstrong cutting-off and grinding machines, drill and reamer holders, lathe tool-post, lathe dog, bolt driver, quick-action drill vise, planet jack, universal ratchet drill, automatic drill drift, C-clamps, etc.

NATIONAL TUBE CO., Frick Building, Pittsburg, Pa. Catalogue H-1909 of material manufactured by the Kewanee Works of the company, embracing wrought pipe for steam, gas, water and air, cast and malleable iron and brass fittings, brass and iron body valves and cocks, drive well points and well supplies. The catalogue is attractively arranged and well printed; some of the illustrations are partly in color to distinguish brass from iron. It should be in the files of all concerns using pipes, valves, cocks, flanges, and other supplies mentioned.

BUCKEYE ENGINE CO., Salem, Ohio. Catalogue of Buckeye electric blue-printing machines with testimonials of many users. The catalogue is unique in that the upper and lower edges of each page imitate the characteristics of blue-prints, being in blue with white lines. The Buckeye Engine Co. was one of the first American concerns to use blue-prints and it has consistently promoted their use for many years.